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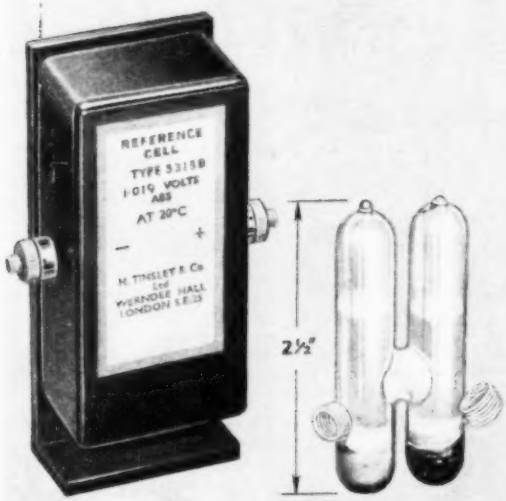

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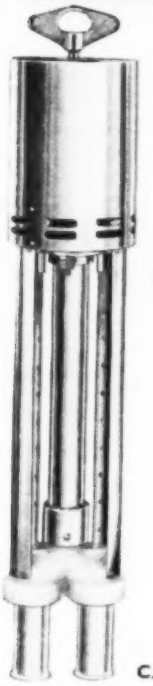

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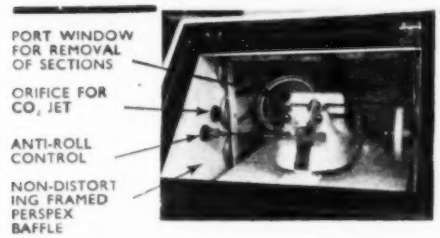

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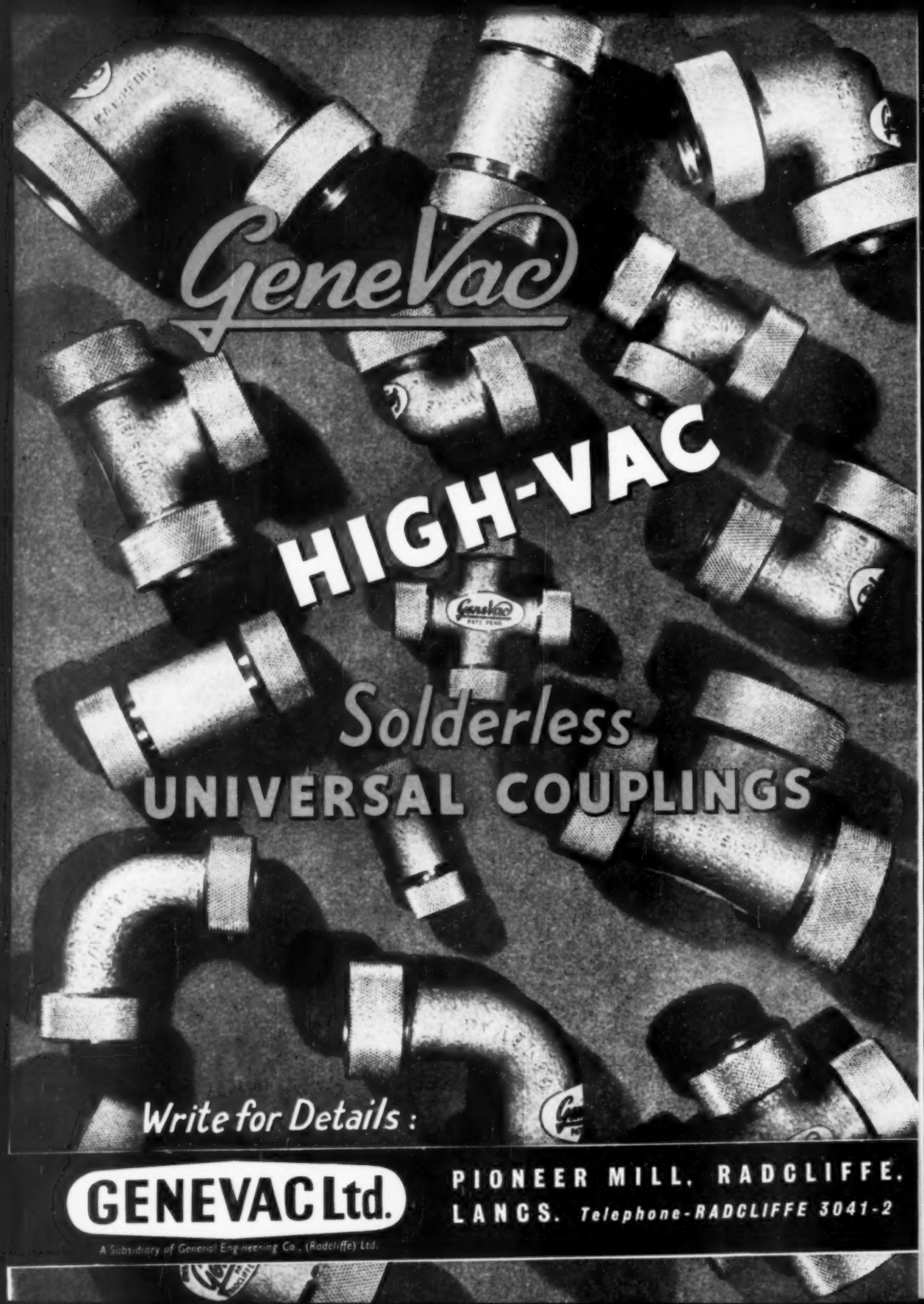
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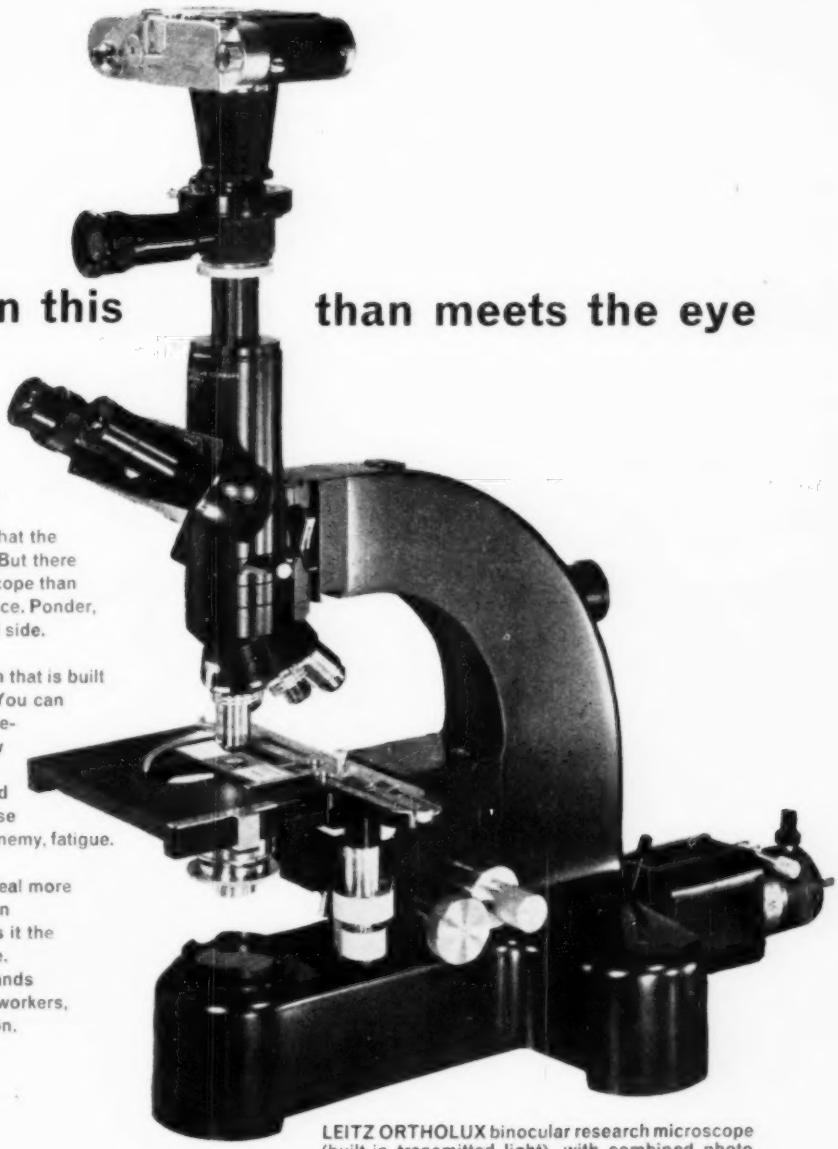

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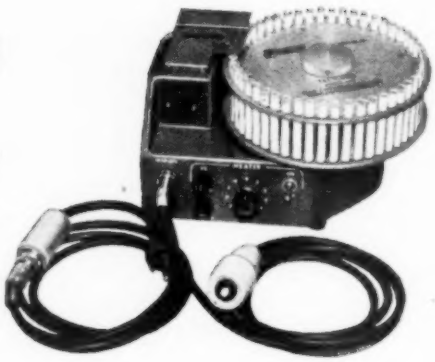

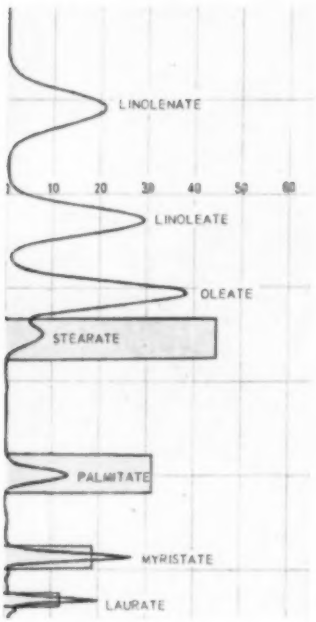

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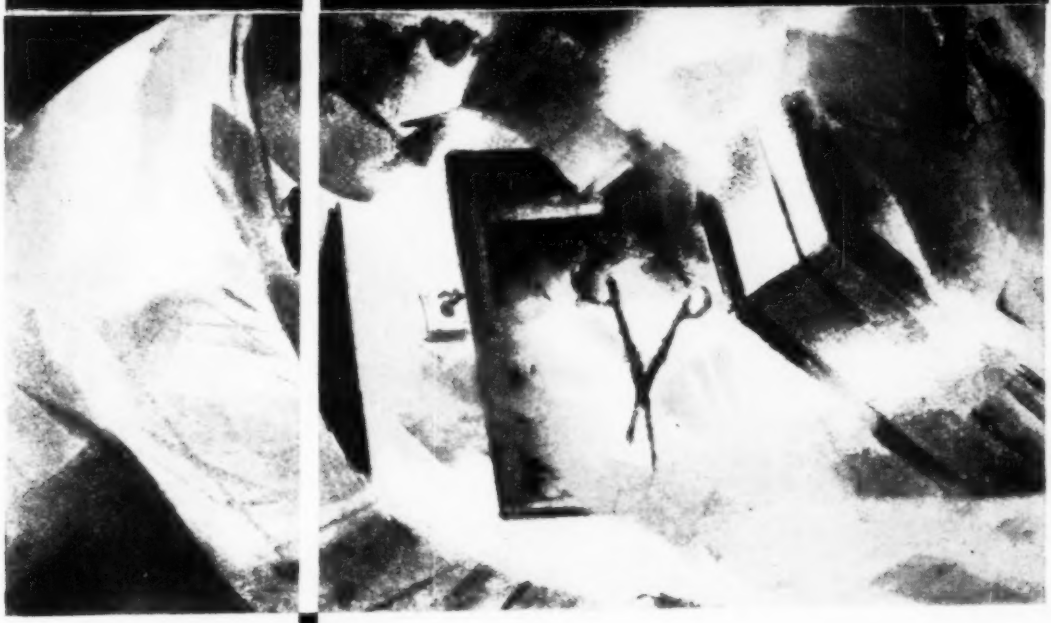

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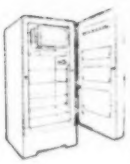

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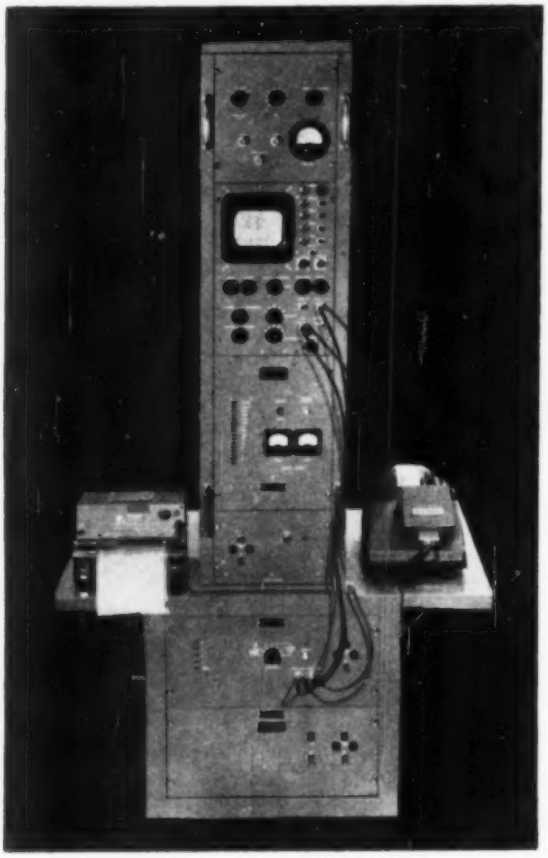

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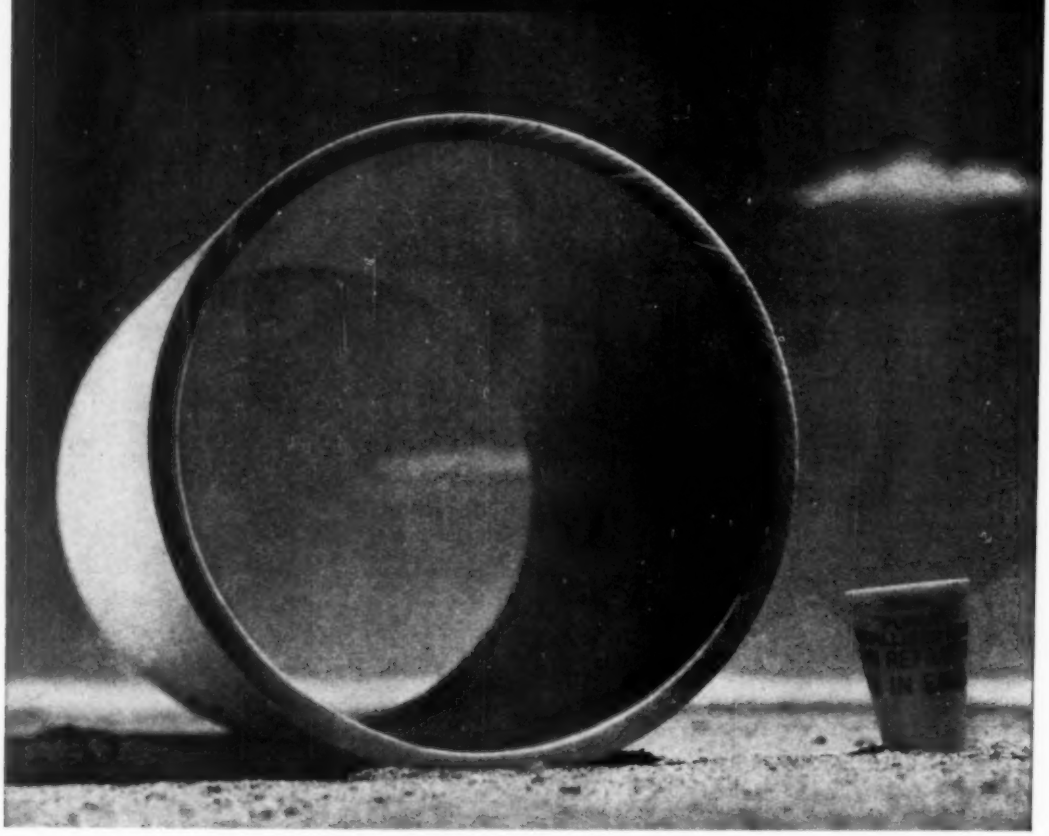

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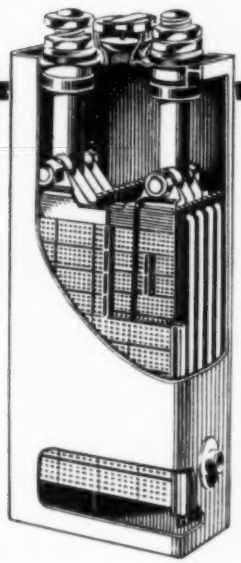

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EMPLOYMENT OF WOMEN SCIENTISTS AND ENGINEERS

THE report of an inquiry conducted by the Social Survey of the Central Office of Information into the employment of qualified women scientists and engineers in private manufacturing industry shows clearly that, in general, industry in Britain is a man-dominated world and is likely to remain so for many years to come*.

The sample of establishments covered by the survey was weighted in favour of industries which employ a high proportion of qualified scientists and engineers, and was drawn from establishments with two hundred workers or more which in 1956 were known to employ scientists and engineers. The number of establishments which took part in the survey was 785, employing between them 16,350 qualified scientists and engineers, that is, about 25 per cent of all those engaged in manufacturing industry.

Of the co-operating establishments, only about 98 (13 per cent) employed women scientists and engineers at the time of the survey. A further 85 (11 per cent) establishments had employed women scientists and engineers in the past but did not do so at the time of the inquiry. The 785 co-operating establishments employed between them 15,972 male and 378 female qualified scientists and engineers; that is, 42 qualified men for every qualified woman. Only eight of the 378 women were engineers. On the assumption that the ratio of scientists to engineers in the sample was the same as in manufacturing industry as a whole, the ratio of male to female scientists was fifteen to one, and of male to female engineers more than a thousand to one.

An interesting feature of the inquiry was the views put forward by managers indicating their reasons for not being enthusiastic about the employment of qualified women scientists and engineers. Three main disadvantages were repeatedly mentioned, namely, that women were too likely to leave because of domestic commitments, including marriage; that there were difficulties about having them in authority over, or working with, male personnel; and that rough, dirty and physically hard working conditions were unsuitable for women.

Despite all the pleadings put forward by women's organizations, these are cogent points to support views strongly held by cost-conscious industrial managements. The training of scientific and technical personnel for responsible positions is an expensive process, and the facilities are much more readily given to those who are likely to stay with firms than those who are likely to go.

Qualified women are unlikely to become acceptable in industry until the shortage of technical personnel has become so acute that employers are prepared to accept them although fully aware of the fact that they are much more likely to have left within a few years than members of the opposite sex. Not all the views expressed by management, however, can be substantiated. Far too much is made of the case that male staffs object to having women in authority over them. In the Social Survey inquiry, for example, there was considerable difference between the views of those managements which had employed women scientists and those which had never employed them. Where there was experience of employing women scientists, it was much more often held that the male staff were in favour of their employment or had no objection to it.

Not unexpectedly, there is far greater objection to the employment of women engineers than women scientists. The conditions under which professional engineers often have to work, for example, dealing with heavy and dirty machinery, plant and site work, and shift work, are regarded as unsuitable for women while the control of male labour in engineering organizations would be possible only for the most exceptional women engineers. It is significant that very few employers in the survey had had any actual experience of employing women engineers.

In many ways the second part of the survey is likely to be of greater use in enabling educated women to find a suitable niche in industry. It was concerned with the actual experience of women who had taken university degrees in science or engineering in recent years. The sample taken was one in two of all women scientists who had graduated in 1954 and 1956. These years were chosen because women who graduated in 1954 could still be traced and would have had at least four years in which to gain experience of employment in industry and elsewhere. Those who had graduated in 1956 would have had only a little more than two years employment: but it was felt to be worth while to find out whether the situation had changed in recent years.

Of the 708 women in the sample, 381 were unmarried, 214 were married without children and 133 were married with children. The number working full-time was 513 (73 per cent), of whom all but 7 were single or married without children. Thirty-five were working part-time and 160 (22½ per cent) were not in paid employment. All except 31 (4 per cent) had had a paid job since graduation. Of the single women in the sample, 92 per cent were working full-time, and, of the married women without children, 73 per cent were working full-time.

Of the graduates who were still working full-time at the time of the survey (513), about half of them were, or had been, employed in teaching. The next largest proportions were engaged in research and development, and testing, analysis and product con-

* *Ministry of Labour Gazette*, September 1960.

trol, which bears out the finding in the employers' survey that these were the jobs in industry in which women scientists were most often engaged. 74 per cent of the graduates were employed in professional services, only 19 per cent in the industries included in the employers' survey, and 7 per cent were in other businesses. The professional services include education, medical and hospital services, and trade and professional associations; other businesses include gas, electricity and water, transport, national and local government, insurance, banking and finance, and catering.

In general, graduates working in private manufacturing industry were earning more than those in the professional services and in other businesses. Thus, of the graduates in private industry, 39 per cent were earning £800 or more per annum compared with 23 per cent in the professional services, and 30 per cent in other businesses. Because of the high proportion of graduates employed in teaching, the level of salaries shown as paid in the professional services must have been greatly influenced by the lower salaries in the teaching profession.

Women science graduates were asked whether their jobs offered prospects of promotion and whether, in their view, male colleagues were given preferential treatment. Of those employed in manufacturing industry more than half (52 per cent) thought that there was no prospect of promotion, and rather less than half (42 per cent) believed that there was. In the professional services, which included teaching, these proportions were reversed. In the 'other businesses' category a much higher proportion of women (69 per cent) thought that there were prospects of a better job.

More than half the women scientists employed in private manufacturing industries thought that their employers showed bias in favour of men as regards pay and promotion, but only 16 per cent in the professional services thought so. There were many in the latter group, however, to whom the question did not apply because all their colleagues, for example, in girls' schools, were women.

From both parts of the survey one conclusion is inescapable. Employers are reluctant to employ educated women scientists and engineers mainly because, on economic grounds, they are a bad risk; the present preponderance of eligible males over females in the population means that less and less females are avoiding marriage. Changing social behaviour has also led to a marked reduction in the age at which marriage is contracted; and, although the majority of newly married women are staying at work for some time after marriage, the age at which they bear their first child is also being reduced. From the employer's point of view, their years of useful service before beginning full-time duties in their homes is very limited. All the well-meaning protestations by women's organizations will not make young women scientists and engineers anything but a bad industrial investment compared with their male counterparts. Most educated women know this and accept it.

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C. H. Browning

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excessive. Flame indicators, too, cannot be advanced seriously in 1960 as other than highly misleading instruments. One might also make a plea for the substitution of a more descriptive name than the time-honoured "Tabular Numbers" for gas volume reduction factors. After all, most numbers come from tables.

These are, however, minor criticisms. The format of the book is clear and convenient, and, with the exception of one or two poorly reproduced photographs and an illegible table on p. 74, the printing is excellent. "Hyde and Jones" is altogether a worthy successor to "Hyde and Mills" and will long form the indispensable vade-mecum of all who, whether from the official or works-control angle, are concerned with the measurement of the calorific value of gaseous fuels. Physicists unconnected with the gas industry will also find in it much of value, and if they are surprised to find that an apparently simple operation is fraught with so many pitfalls they will also find the solution to many of their gas calorimetric problems within its pages. R. J. H. Banks

QUANTITATIVE MORPHOLOGY

Quantitative Zoology

By George Gaylord Simpson, Anne Roe and Richard C. Lewontin. Revised edition. Pp. vii+440. (New York: Harcourt, Brace and Company, 1960.) n.p.

THE first edition of this work was published twenty-one years ago at a time when zoologists, particularly those interested in morphology and systematics, rarely employed statistical methods. In the meantime, interest has tended to shift in many subjects from the individual to the population, with the consequence that the use of statistical methods is much more necessary. The original authors have been joined by Dr. R. C. Lewontin in producing a revised version which, while having the same general plan, is more lucid and has had some mistakes removed. A chapter on the analysis of variance has been added, and the methods given usually assume that a calculating machine is available. The text is essentially a detailed explanation of those elementary statistical methods which are likely to be useful to zoologists in general and taxonomists in particular. Many examples, mostly drawn from the vertebrates, are fully worked out so that no other statistical source would be required. The least mathematical of zoologists should be able to follow the arguments and thereafter apply the methods to his own work. The biological significance of parameters or tests of significance is indicated wherever it is known. The last two chapters deal with graphic methods and with the problems of growth, respectively.

The authors admit that there are now many more good books on biometry, statistics, and general quantitative methods than when this work was first published. The most cogent argument for a new edition was that the book was still in demand though out of print. It is also true that many statistical works, so far as they touch on biology, are biased in the direction of agriculture. It seems debatable, however, whether, in view of the large number of statistical texts available, it might have been possible to reduce this side of the work and to expand it in other directions. The subject of sampling in the actual circumstances of Nature is rarely adequately discussed, and yet it raises many difficulties, though perhaps more for the ecologist. The paragraph on the capture–recapture method is perhaps too short to be useful in view of the real difficulties in interpretation and the many possible modifications of the simplest theory. Possibly the negative binomial distribution might be worth discussing; at least the bibliography might include more references to works in which additional or more refined methods are described.

The great merit of the work as it stands is its lucidity, which in this particular subject is a transcendent advantage. Nearly all taxonomists will find something useful to them in one chapter or another and very little that they cannot understand.

O. W. Richards

SULPHATED POLYSACCHARIDES

Polysaccharides in Biology

Transactions of the Fourth Conference, May 21, 22, and 23, 1958. Edited by G. F. Springer. Pp. 326. (New York: Josiah Macy, Jr. Foundation, 1959.) 5.95 dollars.

THIS is the report of a conference held at Princeton, New Jersey, in May 1958 on the sulphated polysaccharides. There are seven chapters, each associated with a main speaker whose account is followed by a discussion and further contributions. The chapter headings are: chondroitin sulphates (K. Meyer), biology of chondroitin sulphates (R. H. Follis), heparin and related substances (M. L. Wolfrom), the mast cell (R. D. Higginbotham), biosynthesis of sulphated polysaccharides (H. Boström), synthetic non-biological sulphated polysaccharides (M. J. Shear) and sulphated polysaccharides of plants (L. Stoloff).

The style of the book is provocative, and there will not be many neutral opinions about it. As in other Macy 'multiprofessional conferences', the proceedings are reported verbatim, with a few afterthoughts interpolated into the text. To this reviewer the presentation, reading like a playscript, has many merits, but a few 'stage directions' in the way of sub-headings would be helpful. There are no sub-headings within the chapters, and, since these are up to 60 pages long, the index assumes a vital function, but even though this is 20 pages long, in the circumstances it is barely adequate. Moreover, the lack of subdivision makes it difficult to discover when the main speaker has finished, and the contents page gives no inkling that a second speaker may also have presented a lengthy description of his own work. In the chapter associated with Meyer's name, the main speaker in terms of continuous matter is in fact Jeanloz. A further general disadvantage is that this is a conference of experts, and definitions which would be out of place in the conference room are necessary to the less-specialized reader. A glossary would be helpful.

An advantage that could be legitimately expected of this type of presentation is that it should be available for printing as soon as the tape-recorder has yielded its secrets to the typewriter. It is surprising to learn from the publishers that 20 months elapsed between the conference and the book becoming available in January 1960. Much that was new at the conference has since been published elsewhere. Nevertheless, the authoritative nature of the papers and the importance of the subject

will ensure for the book a wide sale and circulation, and the Macy Foundation is to be congratulated on its timely choice of the subject. The book is well produced, attractively priced and contains very few errors.

W. J. WHELAN

POLYPEPTIDES ACTING ON SMOOTH MUSCLES

Polypeptides which affect Smooth Muscles and Blood Vessels

Proceedings of a Symposium held in London on 23rd and 24th March, 1959. Edited by M. Schachter. (Biological Council's Co-ordinating Committee for Symposia on Drug Action Series, Vol. 4.) Pp. xv + 336. (London and New York: Pergamon Press, 1960.) 50*s*. net.

THE Co-ordinating Committee for Symposia on Drug Action, under the chairmanship of Sir Charles Harington, has sponsored discussions at the Wellcome Building in London in the spring since 1955. The subjects of these symposia have been histamine, hypotensive drugs, 5-hydroxytryptamine, and quantitative methods in human pharmacology. The present book deals with the fifth of these symposia, and shows how much this subject has developed since 1953 when fifteen authors contributed to a meeting in Montreal and afterwards published their contributions in a book (*Polypeptides which stimulate Plain Muscle*. Ed. J. H. Gaddum. Edinburgh: Livingstone, 1955).

The structures of oxytocin and vasopressin were first announced at that earlier meeting; now it is possible to discuss the relation between the structure and action of a number of homologues. Oxytocinase has been estimated with an artificial substrate, and a separate vasopressinase has been found in the placenta. Substance *P* resembles these pituitary hormones in that it appears to be stored in nervous tissue, but its structure and function are still unknown. The structure of angiotensin was elucidated in 1956, and the actions of a number of homologues have now been measured, but there are still serious doubts about the relation of this substance to hypertensin.

Kallidin, bradykinin and other kinins form a group with very similar actions. The isolation of bradykinin and its composition in terms of amino-acids were announced at the meeting in 1959; the exact structure is now known.

The final session was devoted to anaphylatoxin, leucotaxine, exudin, globulins affecting permeability and the activation of large molecular substances by injury. Some of these latter substances are still not clearly defined and there is much more work to be done by the chemists who have already done so well in this field.

Some of these polypeptides are thought to play important parts in physiology and pathology. Vasopressin controls the excretion of water, and oxytocin controls the uterus and the breast. The kinins may be released to cause vasodilatation in active tissues. There is clearly much to be discovered about all these substances and every reason to expect that they will prove to be physiologically important.

The symposium was a success because it collected the leading authorities from all over the world. Owing to the generosity of the Wellcome Trust and Sandoz, Ltd., it was possible to invite contributors from the United States, Sweden, Switzerland, Germany and Austria.

The book gives an authoritative summary of work in this field. It has been edited by M. Schachter and is beautifully produced, but rather expensive. It did not appear until a year after the symposium on which it is based, but that was partly due to a printers' strike. It is likely to remain the best summary of work in this field for some time to come.

J. H. GADDUM

SEDIMENTARY ROCK TYPES

Microscopic Sedimentary Petrography

By Prof. Albert V. Carozzi. Pp. viii + 485. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1960.) 92*s*. net.

THE work of Prof. Albert V. Carozzi is well known to geologists by the publication in 1953 of his *Petrographie des Roches Sedimentaires* and by other important papers. Here he describes his work and that of others in English. Throughout the book the author refers to both American and European examples, and the long list of references at the end of each chapter is by no means the least valuable part of this important book. No attempt is made to confuse the student with a wealth of individual examples, but rather to describe ideal types together with the chief variations. From such descriptions it is a relatively simple matter for the research worker to apply such general principles to his own particular problems.

The author divides the sedimentary rocks into three main groups, namely, the clastic, the biochemical and the chemical rocks. The first and last groups are well known to students, but the middle division is less familiar. Under this heading are described carbonate, siliceous, iron-bearing and phosphoritic rocks which possess the common property of having been generated chiefly by organic as well as chemical processes.

In Part 1 the microscopic characters of the clastic rocks are dealt with under the headings of arenaceous, rudaceous, pyroclastic and argillaceous rocks. Microscopic definitions are reduced to an absolute minimum, and in this as in succeeding sections of the book the author directs attention to the great amount of additional knowledge which is still required for a complete understanding of the genesis of many sedimentary rocks.

Part 2 deals with the biochemical rocks, and an evaluation of the relative value of the two processes—organic and chemical—is attempted.

In the concluding part the evaporites are described. These are, perhaps, among the most difficult of all sedimentary rocks to understand, and the author has wisely not theorized further than published descriptions enable him to do so.

Prof. Carozzi's chief interest has always centred on the carbonates, and the many workers in this field will find much of value in his able summary concerning the formation of the oolites and dolomitization.

The book concludes with extensive author and subject indexes, and is well produced on good paper with a pleasing type, though it is unfortunate that it was necessary to price it rather on the high side.

F. S. WALLIS

Mineral Processing

By Dr. E. J. Pryor. Revised and enlarged edition of "An Introduction to Mineral Dressing". Pp. vi+814. (London: Mining Publications, Ltd., 1960.) 90*s*.

THE second edition of Dr. Pryor's book, under a new title, is a revised, extended and improved version of the first. All the illustrations now have captions, it is less pedantic in places and there are improvements in detail of presentation, but some of the criticisms in the notice of the first edition (*Nature*, 177, 908; 1956) are still valid.

Although, as stated on page 3, "Mathematical presentation has been avoided as far as possible in this book", more formulæ are used in the new edition than in the first, but, when they are given just as formulæ, they do not always help the generally empirical approach (which may lead to undue wordiness) in the way that they should. Such mathematical approaches as are used are spoilt by the haphazard use of symbols. Specific gravity and density (no units given) are used indiscriminately and their symbols may be δ, Δ, ρ, γ, or S. The symbol S is used also for the thickness of the double layer, for entropy, for specific surface and for the 'set' of crushing rolls. The symbol R is used for six different purposes and other symbols have multiple uses—one of them for two purposes on the same page. The formula for Reynolds number appears in two places: in one V is velocity, $2r$ is diameter and δ is density; in the other v is velocity, δ is diameter and ρ is density.

The chapter on the physics and chemistry of pulps has been considerably improved; so has the chapter on coal preparation but perhaps not as much as its importance warrants. The chapter "Gold Cyanidation" has been replaced by a chapter "Chemical Extraction" which devotes 58 pages to gold but only an inadequate 14 to "other metals and minerals".

The book as a whole is well arranged and contains a great deal of information, perhaps too much in connexion with details of process and plant operation, some of which might well be omitted in a new edition and the space so released used for more rigorous mathematical approaches to those problems which lend themselves to such treatment. S. G. Ward

Demineralization by Electrodialysis

Edited by J. R. Wilson. Pp. xv+378. (London: Butterworths Scientific Publications, 1960.) 60*s*.

IN 1959, the world's largest electrodialysis plant came into operation at the Free State Geduld mine in South Africa. This plant, with a design capacity of 2,400,000 gallons of desalted water a day, was the outcome of a programme of research and development in the laboratories of the South African Council for Scientific and Industrial Research. This book by the staff of the Process Development Division of the Council's National Chemical Research Laboratory, is a review of the process of demineralization by electrodialysis, and also a technical record of the various stages in the development and construction of the largest electrodialysis plant which has so far been built. The book contains chapters on the electrodialysis process, the physical chemistry of ion-selective membranes, the preparation and characterization of membranes, the design and operation of electrodialysis plant, pilot-plant operations, and the Free State Geduld electrodialysis plant. The later chapters, which include details of the difficulties encountered in the preparation of the ion-selective membranes and in the construction and operation of the plant, will be of value to all who are concerned with the practical application of electrodialysis to water desalting. The earlier chapters will be of wider interest. The book contains a great deal of useful information and is supplemented by a comprehensive bibliography. The index is a little difficult to use, but otherwise the book is well produced, with very good illustrations and diagrams.

D. K. Hale

On Mathematics and Mathematicians

By Robert Edouard Moritz. (Formerly titled "Memorabilia Mathematica or the Philomaths's Quotation Book".) Pp. vii+410. (New York: Dover Publications, Inc.; London: Constable and Co., Ltd., 1958.) 1.95 dollars; 16*s*.

THE publishers of paper-back reprints are not always happy in their choices, but only the very hard-hearted reader will refuse a welcome to this reprint of the "Philomaths's Quotation Book", long out of print and almost unobtainable. From more than 2,000 quotations we can select informed and ill-informed attempts to define mathematics, we can read what Gauss and Henry Smith have said about the theory of numbers or what Condamine said about the Yancos of the Amazon, whose name for three is 'poettarrarorincoaroac': "Heureusement, leur arithmétique ne va pas plus loin". The Sylvester anecdotes alone are worth the price of the book. An excellent bed-side volume; but it has a deeper value. How many of the judgments and opinions which were acceptable in 1914 retain their full worth to-day? If Moritz could give us a 1960 collection of "great thoughts", with quotations from Bourbaki, Brouwer, Hardy, Hogben, Hilbert, Weyl, to name only a few, would the comparison not show a difference in tone and values enough to indicate a profound revolution in our ways of thinking about mathematics? Would it be Trollope against Graham Greene? Theses have been written on less interesting themes.

T. A. A. Broadbent

Handbook of Geophysics

Revised edition. (United States Air Force/Geophysics Research Directorate.) Pp. xvii+657. (New York and London: The Macmillan Company, New York, 1960.) 105*s*.

BY means of excellent diagrams and detailed tables this volume summarizes our knowledge of that part of geophysics concerned with phenomena above the Earth's surface. Much of the information is intended for the engineer designing aeroplanes and rockets; but the compilation will be of great value to the scientist and of considerable interest to the general reader. For example, the chapter on clouds, which gives tables showing the frequency of various ceiling heights of cloud at various places, provides very interesting reading.

There are chapters on the divisions of the atmosphere, its temperature, density and pressure distribution, a discussion of winds, including data on the jet stream, data on the rain and hail distribution and on the composition of the atmosphere. There are charts of the Earth's magnetic field and data on magnetic activity and atmospheric electricity. Basic information on geodesy is given and thermal and cosmic radiation discussed. The propagation of light,

electromagnetic radiation, and sound through the atmosphere is another topic, and there is a very useful chapter on devices for exploring the atmosphere. In places, the writing leaves something to be desired; for example, meteors are defined as "extraterrestrial matter which have penetrated far enough into the earth's atmosphere to become embroiled in a violent reaction with it". S. K. RUNCORN

A Bibliographical Index of the British Flora

Including Floras, Herbals, Periodicals, Societies and References relating to the Identicfiation, Distribution and Occurrence of Phanerogams, Vascular Cryptogams and Charophytes in the British Isles. Compiled by N. Douglas Simpson. Pp. xix+429. (Bournemouth: N. Douglas Simpson, 3 Cavendish Road, 1960.) n.p.

THIS is an ambitious effort to index references concerning the identification, history and geographical range of the flowering plants, vascular cryptogams and charophytes in the British Isles, including Ireland. It also attempts to provide information on plant-lore, local names, poisonous plants and weeds. To accomplish thoroughly such a task would be a prodigious undertaking requiring detailed scrutiny of the vast literature in which records may be expected. It is not surprising, therefore, that the present work is admittedly incomplete, with many publications of local societies and other sources entirely unexamined. The format of the book is unnecessarily elaborate, with the entries, many of them of trivial scientific significance, arranged in a complicated and indeed irksome sequence. Any attempt to give a complete list of species records under the various counties would be a colossal and forbidding task for any individual, and in this volume it seems ill-advised and redundant to include quite an arbitrary selection of such records. The work is undoubtedly the product of great industry and within its limits will certainly be a useful adjunct in the study of the British flora. G. TAYLOR

Founders of British Science

John Wilkins — Robert Boyle — John Ray — Christopher Wren — Robert Hooke — Isaac Newton. By J. G. Crowther. Pp. ix+296+10 plates. (London: The Cresset Press, 1960.) 35*s*. net.

IT is greatly to be hoped that no one will be misled by the title of this book: it is neither an attempt to establish an exclusively 'British science' on the model of the 'Aryan science' of the 'thirties, nor dogmatically to exclude other claimants to the title of its 'founders'. Mr. Crowther's preliminary chapter emphasizes the importance of Gilbert, Napier, Harriot, and Harvey in the 'gestatory period' of British science; indeed, as scientists, all four of these men might be held to be of greater stature than Wilkins. But 'science' for Mr. Crowther, as he has made abundantly clear in earlier writings, is no isolated activity to be followed at the beck of individual whim and genius, but is 'wholly' effective only when the course of its progress is in harmony with social needs. To illustrate this anew, he has examined with great thoroughness the contemporary sources which shed light not only on the scientific achievements of the six well-chosen 'founders' of 'organized' British science, but also on their social circumstances, aspirations, frustrations, and insight into contemporary needs. In a wide-ranging survey of such a controversial question it is inevitable that the account of the facts, and even more of some of the inferences drawn from the facts, will not pass unchallenged; in pressing the argument too hard, the author is sometimes even landed in inconsistency. Also the 'close naked style', which would have pleased his hero, Wilkins, makes some of Mr. Crowther's statements appear more dogmatic than he perhaps intended. But the great virtue of his book is that, apart from its assemblage of a great deal of significant but widely scattered information, it is provocative in the best sense. It is not necessary to go the whole way with Mr. Crowther to welcome his presentation of the thesis that scientists no longer (if they ever did) pass their lives in some empyrean realm in selfless dedication to the pursuit of ultimate truth.

W. P. D. WIGHTMAN

Food Chemistry

By Prof. Lillian Hoagland Meyer. (Reinhold Organic Chemistry and Biochemistry Text-book Series.) Pp. xiv+395. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1960.) 65*s*. net.

PROF. MEYER states in her preface that the aim of her book is to provide a unified picture of foods from a chemical point of view. To this end the emphasis is on the composition of foods and the changes that occur when they are subjected to processing. The book is intended for students who have been trained in organic chemistry, but some chemical background is provided to clarify details of methods of analysis and identification. The book is descriptive rather than didactic in relation to practical work in food chemistry and is not therefore suitable as a laboratory manual. It does, however, provide a readable survey of the nature of fat, carbohydrate and protein components of common foods with additional chapters on flavour and aroma, on meat and meat products, vegetables and fruits, milk and milk products and on cereals. An appendix gives an account of food additives permitted by the most recent lists of the U.S. Food and Drug Administration. A. M. COPPING

Sampling Inspection Tables

Single and Double Sampling. By Harold F. Dodge and Harry G. Romig. Second edition, revised and expanded. (Wiley Publications in Applied Statistics.) Pp. xi+224. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1959.) 64*s*. net.

SINCE the first edition of this book appeared in 1944 it has been one of the most useful sets of tables for scientific sampling inspection. This new edition, on a much larger page, has grown almost out of recognition, mainly because of the addition of a set of diagrams of operating characteristic curves. The four chapters which precede the tables are themselves a valuable introduction to the theory and method of sampling inspection. After these one finds the curves and sampling tables for specified lot tolerance per cent defective and average outgoing quality limit, both for single and for double sampling plans. There is also (an unusual feature in tabular material) a useful index. This is an essential book for the serious student and the factory operator, written with the authority of long experience in teaching and practical application.

M. G. KENDALL

BIOCHEMISTRY OF HEREDITY: A GENERAL HYPOTHESIS

By Dr. IAN LESLIE

Biochemistry Department, Queen's University, Belfast

(1) BIOCHEMICAL RELATIONSHIPS BETWEEN DEOXYRIBONUCLEIC ACID, RIBONUCLEIC ACID AND HISTONES

BECAUSE of major advances in biochemistry during the past ten years, it is now possible to think of the transfer of hereditary characteristics from parents to offspring in chemical terms. The landmarks of progress in this direction are: (1) the realization that deoxyribonucleic acid (DNA) is the primary genetic substance of all cellular organisms[1,2], and (2) the construction by Watson and Crick[3] of a molecular model of DNA, the reality of which now appears to be established[4,5]. The structure is unique, consisting of two complementary polynucleotide strands, linked together by hydrogen-bonding between the base pairs, adenine (A) to thymine (T), and guanine (G) to cytosine (C).

Other vital discoveries concern the function of ribonucleic acid (RNA), which, in contrast to DNA, is not confined to the chromosomal elements of the cells but is spread throughout the nuclear and cytoplasmic regions. The RNA molecules, like those of DNA, are now known to carry genetic information as single-stranded polynucleotides within the sequence of bases A, U (uracil), G and C. This has been demonstrated unequivocally by the discovery that the chemical alteration of the bases in RNA from tobacco mosaic virus produced a mutant virus, in which the protein had a distinctive amino-acid composition[6].

In cellular organisms it is believed the single-stranded template RNA, located in the ribosomes, directs the synthesis of the cell-specific proteins. The association between RNA and protein synthesis has been recognized for some time[7,8]; but its exact role only became known in recent years, largely through the work of Zamecnik, Hoagland and their colleagues[9–11]. Protein synthesis begins with the 'activation' of the amino-acids to produce their adenylate-enzyme complexes which then link the amino-acids to specific 'transfer' RNA molecules. This form of RNA (known as soluble or transfer RNA) is believed to direct the amino-acids into their particular sequence along the *template* RNA[10,12]. The coding operation almost certainly depends on the hydrogen-bonding of the base-pairs, A to U and G to C, but the discovery of the cipher for each amino-acid remains one of the crucial problems of current research (cf. 13, 14).

The Genetic Problem

The present article is concerned solely with the exchange of genetic information between DNA and RNA, and with the mechanism which decides whether the information will be expressed or suppressed in the differentiated cells of higher organisms.

Crick has defined the problem in straightforward and lucid terms[12]. His "central dogma" is that "the transfer of information from nucleic acid to nucleic acid, and from nucleic acid to protein may be possible, but the transfer from protein to protein or protein to nucleic acid is impossible". This is almost universally accepted, as is the concept that RNA is the messenger which carries information from the DNA of the chromosomes to the metabolic regions of the cells. In Crick's terms, the four-letter code given by the bases A, T, G and C has to be translated through RNA to form the twenty-letter amino-acid sequences, which endow proteins with their specific functions. The key to this genetic code lies, therefore, in the base composition of the messenger or *template* RNA, which, by all indications, is produced as single-stranded polynucleotides on the DNA 'master-genes'[13–15].

New information, obtained initially from cultures of human liver cells, has made it possible to formulate a general hypothesis of genetic coding and cellular differentiation. The hypothesis is presented at this stage with the minimum of elaboration. Essentially, there are three main concepts:

(1) Two genetic codes for RNA formation are operating in Nature—one in certain micro-organisms, another in the somatic cells of higher organisms.

(2) Histone proteins act as gene regulators by their ability to 'stabilize' one polynucleotide strand and depolymerize or 'disjoint' the complementary strand which is derived from the 'soluble' or 'transfer' RNA.

(3) In the differentiated cells of higher organisms, part of the histone allows the RNA templates to act as protein synthesizers; another form of histone, located in the nuclei, has the function of suppressing the template function of the associated RNA.

The Base Composition of Template RNA

Human liver cells (strain *HLM*) have been cultured in sufficient amounts for their fractionation into nuclei, combined particles (nuclei, mitochondria, large microsomes), and ribosomes. The nuclei were cleaned by treatment with 0·25 *M* sucrose, 0·01 *M* citric acid at *p*H 3, and the combined particles were spun down at 18,000*g* for 30 min. from 0·44 *M* sucrose buffered at *p*H 7·4. The ribosomes were obtained by treatment of the microsomal pellets with surface-active agents in sucrose medium and sedimentation at 105,000*g* for 2 hr. The determination of base ratios in RNA and DNA gave the following information, which will be published in greater detail elsewhere[20].

(1) The mean DNA base composition, A : T : G : C is 30 : 30 : 20 : 20 and close to the values previously found for human cells[21].

(2) The total RNA of the combined particles has base ratios for A : U : G : C equal to 19 : 18 : 31 : 32.

(*a*) Duplex DNA — Per 100 bases

A—T	30 A
T—A	30 T
G—C	20 G
C—G	20 C
	(determined)

(*b*) Duplex RNA — Per 100 bases

A—U	19 A
U—A	18 U
G—C	31 G
C—G	32 C
	(determined)

(*c*) RNA isolated from nuclear fraction*

RNA template	RNA second strand	Hence duplex RNA		Per 200 bases	Per 100 bases
24 A	24 U	24	A—U	24 39 A	19·5 A
15 U	15 A	15	U—A	15 39 U	19·5 U
37 G	37 C	37	G—C	37 61 G	30·5 G
24 C	24 G	24	C—G	24 61 C	30·5 C
(determined)	(deduced)				

* Substitution in the 'RNA template' column of the ratios A : U : G : C = 14 : 25 : 48 : 13, obtained for the RNA of acid-extracted combined particles, gives the same values in the last column.

Fig. 1. The base compositions of duplex forms of DNA and RNA and their relationship to single-strand RNA isolated from human liver cells (*HLM* strain)

These may reasonably be called the inverse of the DNA ratios; ideally, they would be 20 : 20 : 30 : 30. For convenience, such base compositions in which A = T or U and G = C will be called 'symmetrical'.

(3) Extraction of the combined particles with ice-cold dilute sulphuric acid removed histone protein and about 50 per cent of the original RNA. The composition of the residual RNA was found to be radically changed from the symmetrical pattern of total RNA. The ratios A : U : G : C of 14 : 25 : 48 : 13 are surprisingly close to those of post-microsomal RNA's isolated from guinea-pig pancreas[22].

(4) For the total RNA of citric acid-washed nuclei the base ratios are 24 : 15 : 37 : 24 and are almost identical to values for RNA isolated from rat-liver ribosomes and purified by column chromatography on 'Ecteola' cellulose[23]. Ribosomal RNA from *HLM* cells also has an 'asymmetrical' composition (19 : 18 : 36 : 27).

(5) Acid extraction of histone protein from nuclear and ribosomal fractions caused no loss of RNA and scarcely any change in the asymmetrical base ratios.

The interpretation of these results is given diagrammatically in Fig. 1. The symmetrical ratios for DNA are a recognized feature of its duplex structure (Fig. 1*a*). It is proposed that the symmetrical ratios for total RNA in the combined particles are a consequence of its duplex form in these preparations. The asymmetrical RNA's, on the other hand, are thought to be different molecular populations of *single-stranded template* RNA. If this proposition is correct, the duplex base ratios derived from them arithmetically should be the same as those found for total RNA in combined particles. These are calculated for nuclear RNA (Fig. 1*c*), on the assumption that A bonds to U and G to C. The agreement between the deduced values and symmetrical RNA (Fig. 1*b*) is, in fact, found to be very close.

With the knowledge that the duplex and single-stranded forms of RNA can be isolated by appropriate procedures, and can be recognized by the symmetry or the particular asymmetry of the base compositions, it has been possible to detect these two forms of RNA in the results of other investigators. In some instances, the conclusion that the RNA has been isolated as single-stranded polynucleotide is associated with metabolic evidence suggesting its template function[22,24,25].

Transfer of Template RNA from Nucleus to Cytoplasm

In the present work with human cell cultures, it has been possible to show that the asymmetrical or template RNA is produced in the nucleus and moves to the cytoplasm during interphase. This transfer is a vital feature of present concepts of genetic coding and has been studied intensively in recent years (cf. ref. 26). The movement of RNA from nucleus to cytoplasm has already been made visible in human cells by labelling the nucleic acid with tritiated-cytidine and applying the autoradiographic technique to the coverslip cultures removed at intervals over the subsequent twenty hours[27]. However, in these circumstances, the labelled polynucleotide could consist of both the template and 'transfer' parts of RNA. This doubt has been eliminated by labelling the nucleotides with phosphorus-32 and isolating them from the asymmetrical RNA's prepared from the nuclear and ribosomal fractions.

The discovery that 5-fluoro-2-deoxyuridine inhibits DNA synthesis without immediate effect on RNA formation makes it possible to block mitosis and keep the majority of the cells in the interphase state[28]. Preliminary tests showed that RNA and protein in the *HLM* cell cultures would increase by about 50 per cent in 24 hr., without any concurrent increase in DNA formation. With this experimental system, the changing pattern of labelling in the RNA nucleotides was followed in the nuclear and ribosomal fractions at different times after the cells had been in contact with isotopic medium for one hour. The isotopic medium was completely removed, and the cells continued to metabolize in the 'cold' medium, which was replaced again one hour later to reduce still further the metabolic pool of radioactive phosphate.

The first obvious feature of the labelling was that the specific activities of the RNA nucleotides from the nuclei were four times those of ribosomes at one hour and they were still twice as high at ten hours. After 24 hr. the levels of radioactivity were the same in all fractions. This rapid labelling of nuclear RNA, followed by a gradual levelling-out of the difference between nuclear and ribosomal RNA, is a well-established sequence of events in animal cells[29]. However, unless the labelled nucleotides are known to come from asymmetrical template RNA, it is not possible to conclude from the prior labelling in the nuclei that it eventually moves to the cytoplasm.

When it was realized that RNA had been isolated in template or near-template form (as in ribosomes), the change in pattern of the labelling of the nucleotides with phosphorus-32 with time became understandable. The results of two tests are shown in Table 1. As the specific activities are all expressed relative to the value of 100 for adenine, the more rapid labelling of the nuclear RNA is concealed. The values are intended to emphasize important differences between the related nucleotides, adenylic acid and guanylic acid on one hand, and between uridylic acid and cytidylic acid on the other. It is seen that specific activities are always higher for adenylic acid and uridylic acid than for guanylic acid and cytidylic acid, and that the ratios, adenylic : guanylic and uridylic : cytidylic are greatest in ribosomal RNA at the short labelling-time of one hour. By comparison, the corresponding ratios for nuclear RNA are nearer unity or 'less asymmetrical' at each time of sampling.

The interpretation of these results rests on the knowledge that, in the synthesis of purine nucleotides,

Table 1. Evidence for the Movement of Template RNA from the Nucleus to Cytoplasm during Interphase in Cultures of *HLM* Cells

Source of RNA	Duration of phosphorus-32 metabolism* (hr.)	Relative specific activities of nucleotides (Adenylic acid = 100 counts/min./10 μgm.P)			
		Adenylic acid	Uridylic acid	Guanylic acid	Cytidylic acid
Nuclei	1	100	108	84	85
Ribosomes	1	100	130	49	51
Nuclei	6	100	119	105	108
Ribosomes	6	100	99	66	75
Nuclei	10	100	106	97	94
Ribosomes	10	100	114	87	86
Ribosomes	23	100	109	98	97

* The culture medium contained 0·1 μgm. 5-fluoro-2-deoxyuridine/ml. from 4 hr. before inclusion of 5 μc. $^{32}PO_4$/ml. for a period of 1 hr. Isotopic medium was replaced by non-isotopic medium at 1 and again at 2 hr., and the cells were harvested at times indicated.

adenylic acid precedes in time guanylic acid, and in the synthesis of pyrimidine nucleotides, uridylic acid precedes cytidylic acid[29–31]. This should lead to an initial unevenness of nucleotide labelling which can be expected to disappear when equilibrium with radioactive inorganic phosphate is achieved. (This is found even when the RNA is degraded to 2′(3′)-nucleotides, since in asymmetric RNA there is at least 60 per cent of guanine and cytosine.)

The only likely explanation which can reconcile the coincidence of faster labelling of nuclear RNA with greater asymmetry of radioactivity within ribosomal RNA is that template RNA is formed within the nucleus and moves out to the cytoplasm. The gradual progression towards uniform labelling of nucleotides in both fractions as time proceeds is fully consistent with this interpretation.

Ribonuclease Activity of Histone Protein

The most remarkable feature about histone protein has been the lack of information about its metabolic or enzymic activity. (This was justifiably said of the nucleic acids less than ten years ago (cf. ref. 12).) It has long been recognized as the companion-protein of DNA in animal and plant cells, and the view is still held that histone, like DNA, is confined to the cell nucleus. The one role which has been consistently claimed for it is that the β-histone from nuclei is cell-specific and acts as a gene-inhibitor[32,33]. This has remained hypothetical, because the concept depended on observed differences in composition and electrophoretic behaviour of the proteins rather than on the demonstration of their mode of action.

Within the past two years, the presence of histone-like protein has been confirmed in the ribosomes prepared from animal and plant cells[34–36], and is reported in the smallest ribosomes from *Escherichia coli*[37]. When it became apparent that histone might not be confined to the nucleus, an investigation was begun on its distribution between the nuclei and ribosomes of *HLM* cells. The protein was extracted with ice-cold 0·5 *N* sulphuric acid and precipitated with ethanol[38], before being purified by column chromatography on carboxymethylcellulose (Whatman)[39]. This work was later extended to the histones of guinea pig liver, and the new information which it yielded is now briefly summarized.

(1) The amino-acid composition of the acid-extracted protein from ribosomes of *HLM* cells was shown by paper chromatography to be similar to that of histone[40]. The average arginine concentration was 16 per cent.

(2) The nuclear histones from both *HLM* cells and liver produced four fractions in the eluent from the column. Fraction I was largely polynucleotide material; II, III and IV were histones. Fraction III was arginine-rich (average 22 per cent) and it probably corresponds to the β-histone of Cruft, Mauritzen and Stedman[33].

(3) By contrast, the ribosomal extracts from both *HLM* cells and liver produced only three peaks, corresponding to I, II and IV above. It can be concluded that only histones II and IV are associated with the template RNA which moves from the nucleus to cytoplasm. The profiles of ribosomal and nuclear histones isolated from *HLM* cells are shown in Fig. 2.

There were a number of reasons for proceeding to test the eluted histones for their ribonuclease activities. Chief among them were the reports that highly purified ribosomes contained latent forms of this enzyme, which became active only on releasing the protein from its associated RNA[41,42]. It was also observed that the profiles for the ribosomal histones were similar to those for ribonuclease released from pancreas microsomes by dilute sulphuric acid and separated by column chromatography[43]. The following results were obtained with histones from *HLM* cells and guinea pig liver[44].

(4) Each histone peak from the nuclear and ribosomal preparations showed ribonuclease activity towards yeast RNA[45]. The activities of nuclear histones were higher at *p*H 7·8 (alkaline histone-ribonuclease) than at *p*H 5 (acid histone-ribonuclease), in general agreement with earlier observations on the total enzyme activity in liver nuclei[46]. With the ribosomal histones from *HLM* cells, depolymerization occurred at *p*H 7·8, but the same protein showed virtually no activity at *p*H 5; Tashiro[42] and Roth[47] both report that ribosomes contain latent alkaline

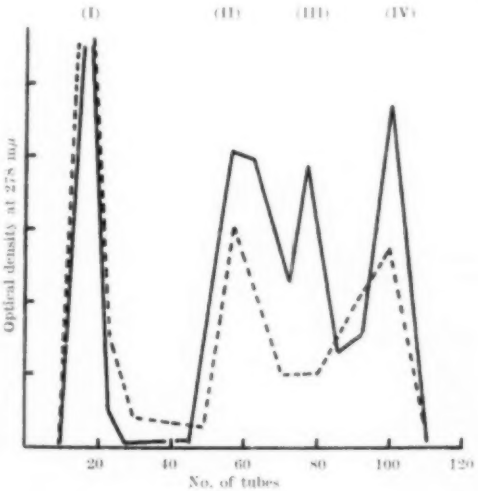

Fig. 2. Histones of human liver cells (*HLM* cells) fractionated by gradient elution from 10-cm. columns of carboxymethylcellulose (Whatman). ——, nuclei; – – –, ribosomes

but not acid ribonuclease. The distribution within these cells of the histone-nucleases with these *p*H optima has still to be fully delineated.

(5) Ribonucleic acid, prepared from guinea pig liver, showed no depolymerization at *p*H 5 in the presence of excess of the combined nuclear histones from this organ. (Excess of histone is present in the assay when there is more than one histone amino-acid for every nucleotide in the substrate RNA.) The same RNA preparation, which had been purified by removal of nucleotide material soluble in ice-cold *N* perchloric acid in 1 hr., was depolymerized by bovine pancreatic ribonuclease and by *HLM* nuclear histone under identical conditions. Confirmation of enzymic activity of the nuclear histone was obtained concurrently with yeast RNA, likewise purified by mild perchloric acid treatment.

(6) The above observations on histone-nuclease activity are found to depend on the presence of sodium chloride of between 0·05 and 0·3 *M* in the assay medium. Further work on the effects of sodium, potassium and magnesium ions is necessary for a proper understanding of histone-nuclease action.

(7) As regards the nature of the specially prepared RNA used in these tests, there is sufficient evidence, based upon the recognition of the base compositions of single-strand and double-helix RNA, to indicate that it is the single-strand, template form of the nucleic acid.

This work on the interaction between histone fractions and RNA from different sources is continuing, but it already shows that histones can act as depolymerases towards RNA, if the RNA is not their associated template form. Their stabilizing action towards template RNA is indicated by the absence of any breakdown when homologous RNA was incubated with excess of the combined nuclear histone in the absence of saline and magnesium ions. This suggests that RNA is stabilized by histone when the ionic conditions promote bonding between the RNA and histone moieties.

Genetic Function of Histone-nuclease

It is proposed that each RNA template has specific stabilizing histones, which can act as depolymerases towards polyribonucleotides of different base composition. Experimental support for this concept is implicit in the present results and in three illuminating papers on the latent ribonuclease activity in ribonucleoproteins[42,47,48]. There are also such clear-cut distinctions between the effects on 'synthetic' polyribonucleotides as the ability of bovine pancreatic ribonuclease and an alkaline ribonuclease from rat liver to degrade polyuridylic acid but not polyadenylic acid[49]. The more subtle aspects of the inverse behaviour of different nucleases have been described by Hilmoe[50].

Logically, it is a short step from this view of histone-ribonuclease action to the concept that each stabilizing histone of single-strand template RNA is the depolymerase for its complementary strand formed during protein synthesis. Although a reasoned case could be made for this particular 'all-or-none' action of ribonuclease, it would be premature to do so until it is known whether the minor nucleotides (pseudouridine, 5-methylcytosine, 6-methylaminopurine, etc.), found mainly in soluble RNA[51], are also part of the complementary strand.

It is postulated that histones, like template RNA, are formed on the DNA genomes and may have the function of stabilizing the RNA templates while acting as depolymerases towards the complementary strands. If separated from the RNA, they will depolymerize any unprotected RNA molecules of different base composition. It follows that the association of nucleic acid with specific histone-nucleases[48] may be the means of suppressing the continuity of the polynucleotide strands which would pass on the 'wrong' information in protein synthesis.

Stent[52] has discussed this problem of 'active' and 'passive' strands in relation to genetic coding systems, and from Hotchkiss[53] has come the suggestion that "theories of DNA replication should take into account the enormous stability that one single-helix running in one direction could have towards an enzyme actively engaged in exchanging base residues at the end of a chain which is being synthesized in close proximity along an opposite direction". These concepts form an integral part of the hypothesis that there are in existence two coding systems for exchanging genetic information between DNA and RNA.

(2) GENETIC CODING SYSTEMS IN CELLS AND VIRUSES

Four coding systems have been proposed for the transfer of genetic information from DNA genomes to the RNA templates required for protein synthesis[52,54–56]. All involve the assumption that the purines and pyrimidines *or* their base-pairs, A–T and G–C, along the DNA chains determine the base sequence in the derived single-strand RNA. The ciphers for these codes are shown in Table 2. Three envisage the formation of RNA on duplex DNA and the fourth adopts RNA base-pairing rules, analogous to those in DNA, for producing an RNA strand from a single gene-strand. This last code is attributed to Rich[55], as he has presented the case for it in some detail.

Zubay[54] and Sinsheimer[56] developed their coding systems from the observation of certain trends in the base compositions of RNA and DNA in metazoan and unicellular organisms. The basis of Zubay's code is the near-equivalence in animal cells of the ratio (G + C)/(A + U) in nuclear RNA with the ratio (A + T)/(G + C) in the associated DNA. This led him to propose that the base-pairs A—T and T—A locate either cytosine or guanine on single-strand RNA, according to their orientation along the double-helix; similarly, G—C and C—G locate the position of the bases adenine and uridine, and thus determine the sequence along the RNA strand. The four possible arrangements of this coding system are given in Table 2.

Sinsheimer's coding system was designed to reconcile the paradox of the apparent co-existence of DNA of widely different composition with RNA of more uniform composition in a range of bacterial organisms. Essentially, his system allows the base-pair C—G to be substituted for A—T without altering the base sequence of the derived RNA. Again there are four possible combinations of this code, as shown in Table 2.

The individuality of the coding systems of Rich and Stent[52] lies in the manner of their operation. Stent envisages the growth of RNA as a third strand in the deep groove of the DNA duplex, while Rich

Table 2. Possible Coding Schemes for the Transfer of Information between DNA and RNA

Coding system	Proposed rules*	Possible combinations for transfer: DNA to RNA. RNA bases			
		Adenine	Uracil	Guanine	Cytosine
Duplex: DNA to single-strand RNA	*Zubay* (ref. 54)				
	AT or *TA* gives G or C	(*a*) GC	CG	AT	TA
		(*b*) CG	GC	TA	AT
	GC or *CG* gives A or T	(*c*) GC	CG	TA	AT
		(*d*) CG	GC	AT	TA
	Stent (ref. 52) As in next column	TA	AT	CG	GC
	Simsheimer (ref. 56)				
	AT/CG give *G/U* or *A/C*	(*a*) TA	CG	AT	GC
		(*b*) AT	GC	TA	CG
	TA/GC give *C/A* or *U/G*	(*c*) CG	TA	GC	AT
		(*d*) GC	AT	CG	TA
Single-strand DNA to single-strand RNA	cf. Rich (ref. 55) based on Watson-Crick base-pairing	T	A	C	G

* Italics indicates DNA base-pairs.

suggests, for stereochemical reasons, that a single strand of RNA could form on a strand of DNA, producing a transient hybrid molecule. Both these codes have a single cipher for the four RNA bases by which, for example, A and A—T locate the position of uridine in the RNA strand. They adhere, in effect, to the hydrogen-bonding rules for the DNA duplex.

A vital difference underlies this similarity in their 'message'. In the single-strand system of Rich, each strand from duplex DNA should be capable of producing an RNA template. Owing to their opposite polarity, these strands would carry contradictory information to the sites of protein synthesis. Either the concept of 'active' and 'passive' DNA strands must be invoked[52], or a mechanism must exist for suppressing one template while eliciting the expression of the other.

Conditions for Testing Genetic Coding Systems

Knowing the base compositions of single-strand RNA and the conditions for isolating it in this form, it is possible to test the validity of these four coding systems. Thoroughly rigorous criteria for such tests would require:

(1) Independent confirmation that the template RNA was single-stranded by physicochemical studies or by the demonstration of its ability, when in ribosomes, to direct specific protein synthesis.

(2) The isolation from the same tissue of RNA in its double-helical form, and the knowledge that its base composition agrees with the duplex ratios calculated from the single-strand or asymmetric RNA as shown in Fig. 1.

(3) An established base composition for the DNA of the species.

For the present, it is not possible to satisfy fully these conditions. Since the hypothesis is intended to lead to experimentation and discussion, it will be developed from the available information.

Table 3 gives the base compositions of RNA and DNA from human cells, rat liver and pea seed roots. The reasons for the assumption that two RNA complexes have been isolated from the human liver cells in their single-strand form are given above. The extent of the base-ratio asymmetry can be judged from the factor in the second-last column of Table 3. This increases as the numerical gaps between adenine and uridine, and between guanine and cytosine, widen. The values of the factors are, of course, very low or zero in duplex forms of RNA and DNA.

The base ratios for single-strand RNA of rat liver are those of RNA II isolated by column chromatography on 'Ecteola' cellulose by Goldthwait[29], who observed that it was similar to post-microsomal RNA and did not act as 'transfer' RNA, unlike the accompanying RNA. It is seen that the duplex composition, calculated from the base ratios of RNA II, resembles closely a determined symmetrical RNA, isolated from whole-cell preparations by Elson and Chargaff[57]. The inverse patterns of the base compositions of duplex forms of DNA and RNA are again evident in these cells, and this relationship is, in fact, a characteristic feature of the nucleic acids in animal and plant cells.

The asymmetrical RNA of pea seed roots came from the nucleic acid, which remained in the thin transverse segments of the tissue after extraction with *N* perchloric acid at 2–4° over 30 hr.[58]. There is evidence that the degradation of the complementary strand occurs under such conditions[20] and the increased amounts of residual RNA found in the more mature cells[58] are consistent with its template nature.

Genetic Coding in Animal and Plant Cells

The consequences of applying the coding systems of Zubay[54] and Rich[55] to the data for human liver cells are illustrated in Fig. 3. By using the ciphers given in Table 2, the composition of the DNA necessary to operate can be calculated from the asymmetric base-ratios of RNA. Only the first arrangement of the Zubay code is applied, since the others obviously give

Table 3. Base Compositions and Asymmetry Factors for Single-Strand and Duplex Forms of RNA and DNA from Metazoan Cells

Species and tissue	Nucleic acid	Base composition (number per 100 bases)				Asymmetry factor[b]	Ref. No.
		Adenine	Uracil/thymine[a]	Guanine	Cytosine		
Human liver (*HLM* cells)	Single-strand RNA[c]	24	15	37	24	22	—
	[d]	14	25	48	13	46	—
	Duplex RNA[e]	19	18	32	31	2	—
	Duplex DNA	30	30	20	20	0	—
Rat liver	Single-strand RNA	25	13	38	24	26	23
	Duplex RNA-calc.[f]	19	19	31	31	0	—
	Duplex RNA-deter'd.	18	20	32	30	4	57
	Duplex DNA	29	29	21	21	0	21
Pea seed roots[g]	Single-strand RNA	27	17	39	17	22	58
	Duplex RNA-calc.[f]	22	22	28	28	0	—
	Duplex DNA	29	30	20	21	2	58

[a] Thymine replaces uracil in DNA.
[b] This factor is the sum of the differences between A and U and G and C.
[c] Is isolated from nuclear fraction washed with sucrose-citric acid medium.
[d] Is isolated from combined-particles after histone extraction (see Fig. 1 and text).
[e] Is isolated directly from combined-particles.
[f] Calculated from single-strand RNA as shown in Fig. 1*c*.
[g] Residual RNA and DNA in tissue after treatment with ice-cold *N* perchloric acid for 30 hr.

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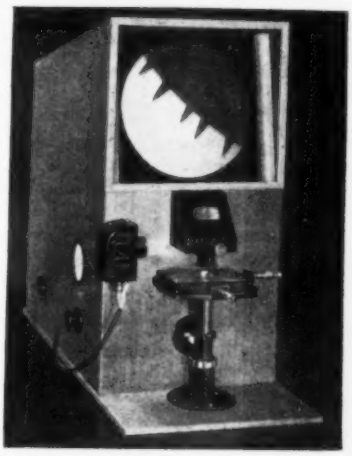

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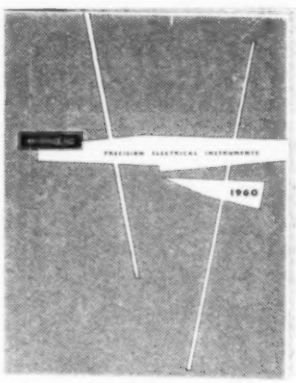

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(*a*) Base-pair coding (for example, Zubay[54]).

RNA nuclear	DNA base-pairs	Hence in DNA	Per 100 bases	Conclusion
24 A	G—C (24)	A = 37 + 24	30·5 A	Similar to determined composition of DNA. *Code valid*
15 U	C—G (15)	T = 24 + 37	30·5 T	
37 G	A—T (37)	G = 24 + 15	19·5 G	
24 C	T—A (24)	C = 15 + 24	19·5 C	

(*b*) Single-strand coding (cf. Rich[55]).

RNA nuclear	DNA template	Hence DNA second strand	DNA bases	Per 100 bases	Conclusion
24 A	T 24	A 24	A = 24 + 15	19·5 A	Reverse of determined composition of DNA. *Not valid*
15 U	A 15	T 15	T = 15 + 24	19·5 T	
37 G	C 37	G 37	G = 37 + 24	30·5 G	
24 C	G 24	C 24	C = 24 + 37	30·5 C	

N.B. The same results are obtained with the base composition of RNA isolated from combined-particles after histone extraction.

Fig. 3. Procedures for testing coding schemes illustrated with data obtained from human liver cells (*H LM*)

the same result. If the derived composition agrees with the determined one for the RNA, the code may be said to be valid. If it gives the inverse pattern to the actual one, the code is clearly not valid. This unequivocal answer is obtained when the double-strand system of Zubay is compared with the single-strand code of Rich. The DNA base ratios in Fig. 3*a* are very close to the observed values, while in Fig. 3*b* they are clearly the inverse.

As Table 4 shows, such a straightforward distinction cannot always be made when testing the validity of the codes. While there is no doubt that single-strand coding does not apply to animal and plant cells, ambiguity of decision appears when the first two arrangements of the Sinsheimer code are compared with the Zubay system. An arbitrary rating system has been devised to assist in the judgment of their validity (see footnote to Table 4). It indicates a slightly greater identity between derived and determined values for DNA when the Zubay code is applied, since for the rat and pea data the system is *probably* valid, whereas with the Sinsheimer code it is *possibly* valid. However, it cannot be concluded on such grounds that one operates and the other does not. More cogent reasons for rejecting the Sinsheimer code in favour of the Zubay system will be given later.

The vital feature of these tests is that they indicate that the exchange of genetic information between single-strands of DNA and RNA does not occur in these metazoan cells, and that the coding system which operates involves the formation of template single-strand RNA by the genetic activity of the duplex form of DNA.

Genetic Coding in Unicellular Organisms

The DNA and RNA of unicellular organisms have similar base-ratios for their symmetrical forms (Table 5). This is in complete contrast to the inversions characteristic of these nucleic acids in animal and plant cells (cf. Table 3). Where DNA from *Tetrahymena*[59] has adenine plus thymine in excess of guanine plus cytosine, the symmetrical RNA from this protozoan is similarly weighted. Likewise, when guanine and cytosine are high, as in the DNA of *Aerobacter aerogenes*[60], *Escherichia coli*[60] and *Mycobacterium tuberculosis*[61], these bases predominate in the duplex RNA form.

There are sound reasons for regarding base-ratios in Table 5 which have asymmetry factors of 12 and 13 as single-stranded forms of the nucleic acid. The RNA of *Aerobacter aerogenes* was prepared by a series of fractionations in the presence of surface-active agents[62]. All the recent information on the ribosomes from *Escherichia coli* suggests that they contain active template RNA[25,63,64]. In the analysis of the base-ratios of RNA from the 30S, 50S and 70S ribosomes, Spahr and Tissières[65] appear to have isolated the nucleic acid in its template form.

When the different coding systems are tested, as in Table 6, with these base-ratios, it becomes obvious that the method of exchanging genetic information between DNA and RNA in some micro-organisms is entirely different from that operating in animal and plant cells. The systems of Zubay and Sinsheimer (codes *a* and *b*, Table 2) are unmistakably eliminated by the data for unicellular organisms. Instead, the bacterial cells could employ either the duplex systems of Stent and Sinsheimer (codes *c* and *d*, Table 2) or the single-strand information exchange of Rich. The duplex forms of DNA and RNA in *Mycobacterium*

Table 4. Application of Coding Schemes to Data for RNA and DNA Base Compositions of Metazoan Cells (Table 3)

Species and coding system*	Nucleic acid	Base composition (number per 100 bases) Adenine	Uracil/thymine†	Guanine	Cytosine	Validity of code‡
Man	*Determined* Single-strand RNA§	24	15	37	24	
	Duplex DNA	30	30	20	20	
	Derived Duplex DNA	30·5	30·5	19·5	19·5	Valid
Zubay (*a–d*)						
Stent (1 code)		19·5	19·5	30·5	30·5	Not valid
Sinsheimer (*a–b*)		30·5	30·5	49·5	19·5	Valid
(*c–d*)		19·5	19·5	30·5	30·5	Not valid
Rich (1 code)		19·5	19·5	30·5	30·5	Not valid
Rat	*Determined* Single-strand RNA	25	13	38	24	
	Duplex DNA	29	29	21	21	
	Derived Duplex DNA	31·0	31·0	19·0	19·0	
Zubay (*a–d*)						Probable
Stent (1 code)		19·0	19·0	31·0	31·0	Not valid
Sinsheimer (*a–b*)		31·5	31·5	18·5	18·5	Possible
(*c–d*)		18·5	18·5	31·5	31·5	Not valid
Rich (1 code)		19·0	19·0	31·0	31·0	Not valid
Pea	*Determined* Single-strand RNA	27	17	39	17	
	Duplex DNA	29	30	20	21	
	Derived Duplex DNA	28·0	28·0	22·0	22·0	
Zubay (*a–d*)						Probable
Stent (1 code)		22·0	22·0	28·0	28·0	Not valid
Sinsheimer (*a–b*)		33·0	33·0	17·0	17·0	Possible
(*c–d*)		17·0	17·0	33·0	33·0	Not valid
Rich (1 code)		22·0	22·0	28·0	28·0	Not valid

* Ciphers for the four codes are shown in Table 2.
† Thymine replaces uracil in DNA.
‡ Rating system—*valid* if within ±1 of base number in determined DNA; *probable* if ±2 of base number; *possible* if within ±4 of base number; *not valid* if the inverse of determined DNA.
§ Application of the base composition obtained by method *d* (Table 3) leads to the same conclusions.

Table 5. Base Compositions and Asymmetry Factors for Single-Strand and Duplex Forms of RNA and DNA from Unicellular Organisms

Species	Nucleic acid	Base composition (number per 100 bases)				Asymmetry factor[b]	Ref. No.
		Adenine	Uracil/thymine[a]	Guanine	Cytosine		
Aerobacter aerogenes	Single-strand RNA	26	20	30	24	12	62
	Duplex RNA-calc.[c]	23	23	27	27	0	—
	Duplex DNA	21	21	29	29	0	60
Escherichia coli	Single-strand RNA	24	21	32	23	13	65
	Duplex RNA-calc.[c]	22	22	28	28	0	—
	Duplex DNA	21	21	29	29	0	60
Mycobacterium tuberculosis[d]	Duplex RNA	20	19	31	29	3	61
	Duplex DNA	18	17	33	32	2	61
Tetrahymena[d]	Duplex RNA	31	30	20	19	2	59
	Duplex DNA	37	37	11	15	4	59

[a] and [b] See footnotes in Table 3.
[c] Calculated from RNA (single-strand) by procedure shown in Fig. 1*c*.
[d] No values for RNA (single-strand) available.

tuberculosis[61] and *Tetrahymena*[59] show that they probably adopt a similar coding system.

It is found that the compositions of DNA and RNA from a wide range of bacteria confirm in a general way these conclusions. Belozersky and Spirin[60] noted that extremes in DNA composition (cf. Table 5) were accompanied by RNA of more uniform composition. This becomes understandable now that it is apparent that RNA must be isolated in either its single-strand or duplex form in order to reveal its correct base relationship to DNA. The correlation was, however, sufficiently good for the authors to suggest that "part at least of the ribonucleic acid depends on the deoxyribonucleic acid, and that the two nucleic acids may even be similar with respect to their base compositions". Perhaps it can now be said that they are—in their duplex forms.

Nature of Viral Nucleic Acid

Single-strand nucleic acids are known to form the core of two viruses. They are the RNA of tobacco mosaic virus[66,67] and the DNA of the small bacteriophage ΦX174, investigated by Sinsheimer[68]. Their asymmetrical base-ratios[65,69] are shown in Table 7 along with the compositions of other viruses and of the RNA or DNA of the host cells. Influenza[70] and poliomyelitis[71] viral RNA's are seen to have similar base asymmetry to 'single-strand' RNA of the chick chorioallantoic cells[72] and *HLM* cells.

A fascinating relationship between the nucleic acids of virus and host cell was revealed when the duplex base-ratios were calculated from single-strand values. With animal, plant and bacterial viruses there was, in each case, a 'cross-over' in the pattern of bases in viral nucleic acid and host RNA or DNA (cf. Table 7). The precision of this inversion is particularly impressive with the viruses of tobacco leaf and *Escherichia coli*. (The similar relationship between polio virus Type I and influenza *LEE* (*B*) strain and host RNA is based on the assumption that these viruses also contain single-strand RNA.)

It may be concluded that, for all the above viruses, the RNA or the DNA represents the 'antithesis' in base composition of the template nucleic acid of the host cells. The 'cross-over' pattern also exists between the duplex DNA in certain viruses (for example, *T2r* and *T7*)[73] and the nucleic acids of the infected *Escherichia coli* as seen in Table 7. There is one puzzling exception, quite apart from the problems arising from these observations; the duplex base ratios of bacteriophage *T3* are unique in having the same base-pattern as the DNA of *Escherichia coli*. It is possible, however, that this aberration can be reconciled, since fraction IV of the bacterial DNA, isolated by column chromatography[74], has a base-pattern which is the inverse of the viral DNA and of the total DNA of the cells (cf. Table 7).

Possible Interpretations

No attempt will be made in this article to explore the genetic consequences of these findings. They cover a wide range of knowledge, and time is needed for reflexion and discussion. For the present, it would seem that the relationships found to exist between DNA, RNA and the histones are more than fortuitous, and they suggest to me a number of concepts which may help to make genetic processes understandable in biochemical terms.

(1) The exchange of genetic information between DNA and RNA is carried out by one coding system in animal and plant somatic cells and by another in some unicellular organisms.

(2) Such ambivalence of code might be provided by the Sinsheimer system, since two of its ciphers could operate in metazoan cells (Table 4) while the other two could operate in micro-organisms (Table 6). It is, therefore, not 'indeterminate', as Sinsheimer intended it to be[68]. There are other conceptual reasons which make its 'universality' improbable. For example, it seems too insignificant a change in

Table 6. Application of Coding Systems to Data for RNA and DNA Base Compositions of Unicellular Organisms (Table 5)

Species and coding systems*	Nucleic acid	Base composition (number per 100 bases)				Validity of code‡
		Adenine	Uracil/thymine†	Guanine	Cytosine	
Aerobacter aerogenes	*Determined* Single-strand RNA	26	20	30	24	
	Duplex DNA	21	21	29	29	
	Derived					
Zubay (*a–d*)	Duplex DNA	27·0	27·0	23·0	23·0	Not valid
Stent (1 code)		23·0	23·0	27·0	27·0	Possible
Sinsheimer (*a–b*)		28·0	28·0	22·0	22·0	Not valid
(*c–d*)		22·0	22·0	28·0	28·0	Prob-able
Rich (1 code)		23·0	23·0	27·0	27·0	Possible
Escherichia coli	*Determined* Single-strand RNA	24	21	32	23	
	Duplex DNA	24	24	26	26	
	Derived					
Zubay (*a–d*)	Duplex DNA	27·5	27·5	22·5	22·5	Not valid
Stent (1 code)		22·5	22·5	27·5	27·5	Prob-able
Sinsheimer (*a–b*)		28·0	28·0	22·0	22·0	Not valid
(*c–d*)		22·0	22·0	28·0	28·0	Possible
Rich (1 code)		22·5	22·5	27·5	27·5	Prob-able

*, † and ‡ as in Table 4.

Table 7. Base Compositions and Asymmetry Factors for Single-Strand and Duplex Forms of RNA and DNA from Viruses and their Host Cells

Virus and host cells	Nucleic acid	Base composition (number per 100 bases)				Asymmetry factor*	Ref. No.
		Adenine	Uracil/thymine	Guanine	Cytosine		
Poliovirus Type I	Single-strand RNA	31	25	26	18	14	71
	Duplex RNA-calc.	28·0	28·0	22·0	22·0	0	—
HLM cells (human)	Single-strand RNA	24	15	37	24	22	—
	Duplex RNA-calc.	19·5	19·5	30·5	30·5	0	—
Influenza *LEE(B)* strain	Single-strand RNA	23	36	18	23	18	70
	Duplex RNA-calc.	29·5	29·5	20·5	20·5	0	—
Chorio-allantoic membrane (chick)	Single-strand RNA	22	18	33	27	10	72
	Duplex RNA-calc.	30·0	30·0	30·0	30·0	0	—
Tobacco mosaic virus	Single-strand RNA	29	28	25	18	8	69
	Duplex RNA-calc.	28·5	28·5	21·5	21·5	0	—
Tobacco leaf	Single-strand RNA	24	19	33	24	14	69
	Duplex RNA-calc.	21·5	21·5	28·5	28·5	0	—
Bacterio-phage ΦX174	Single-strand DNA	24	31	25	20	12	68
	Duplex DNA-calc.	27·5	27·5	22·5	22·5	0	—
Escherichia coli	Single-strand RNA	24	21	32	23	12	65
	Duplex RNA-calc.	22·5	22·5	27·5	27·5	0	—
Bacterio-phages *T2r*	Duplex DNA	32	32	18	18†	0	73
T3	Duplex DNA	24	24	26	26	0	73
T7	Duplex DNA	26	26	24	24	0	73
Escherichia coli	Duplex DNA	24	24	26	26	0	60
	Duplex DNA (1V)‡	27	27	23	23	0	74

* As defined in Table 3. † Includes 5-methylcytosine. ‡ See text (ref. 74).

coding to account for the evolution from asexual life to the multicellular and sexual nature of higher organisms.

(3) Zubay devised his coding system to account for inversion of the base ratios for DNA and RNA in animal nuclei. The inversion is confirmed for their symmetrical forms, and it is seen that four stereochemical arrangements of the Zubay system could function in animal and plant cells (Table 4). Zubay[75] has himself provided reasons for rejecting the code, but its observed validity in some metazoan cells leads one to suggest that mating genomes or paired chromatids[76] produce single-strand template RNA within a three-dimensional nucleohistone complex[77,78].

(4) The systems of Stent[52] and Rich[55] are valid for micro-organisms, and the Zubay code is definitely eliminated (Table 6). There are stereochemical grounds for rejecting the use of double-strand DNA templates, proposed by Stent (cf. ref. 55). Thus, single-strand coding between DNA and RNA is more likely to be associated with unicellular organisms and short generation times, whereas, in metazoan cells, double-strand coding by a Zubay cipher is associated with diploid and polyploid cells and longer generation times.

(5) It may be possible, through single-strand coding, to reconcile the co-existence of wide differences in DNA composition in certain micro-organisms (cf. ref. 79) with the known similarity of their protein, as both the DNA strands are theoretically able to act as the genetic templates. There is the interesting contrast that the DNA base ratios of animals and plants are remarkably uniform[21,80].

(6) The presence in ribosomes of histone-like proteins which are latent ribonucleases (and possibly deoxyribonucleases[48]) may provide a mechanism for protecting template RNA while suppressing 'free' RNA of different base composition. In particular, this selective action could prevent complementary polynucleotide from achieving any permanence.

(7) Three distinct histone fractions with ribonuclease activity are found in the nuclei of human and guinea pig cells, while there are only two in the cytoplasmic ribosomes. It seems possible that certain nuclear histones suppress RNA template function and thereby control the differentiation of cells in higher organisms, as originally proposed by Stedman and Stedman[32].

(8) Virus nucleic acids in their duplex forms are usually found to have base compositions which are the 'antithesis' of the corresponding nucleic acids of the host cells. This property may give them immunity to most of the depolymerases of the host cells, while, at the same time, ensuring their replication by association with a particular histone in the host cell. It may be significant that the RNA viruses so far detected only infect animal and plant cells, in which the DNA is always linked to histone, in contrast to the reported absence of the histone moiety in bacterial cells[81,82].

(9) Recently, the discovery that animal viral RNA (Sanders, F. K., personal communication) is first synthesized within the nuclei of the host cells suggests that it may find there 'activating' histones and possibly replicate by single-strand coding through a DNA template as suggested by Rich[55]. Conversely, it is significant that, when DNA bacteriophages infect *Escherichia coli*, an RNA distinct from host cell RNA and similar to phage DNA[83,84] is formed before any DNA of the progeny can be detected.

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Note added in proof. Yčas and Vincent[85] have compared the specific activities of the 2′,3′ and 5′ forms of nucleotides obtained from RNA extracted from yeast cells with boiling 2 *M* sodium chloride. The pattern of asymmetry of labelling with phosphorus-32 in both forms of nucleotides is in general similar to the pattern observed in the 2′,3′-nucleotides from nuclear and ribosomal RNA of *HLM* cells at short labelling times. Analysis of their results leads the authors to conclude that there is, in their material, a small fraction of RNA with a high rate of turnover which is closely similar in base composition to that of yeast DNA. Their suggestion that this RNA might be a primary gene product is compatible

with its formation by the Rich[55] or Stent[52] coding systems for RNA template formation.

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A TRANSATLANTIC COMMUNICATION EXPERIMENT VIA *ECHO* I SATELLITE

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THE *Echo* I satellite, launched on August 12, 1960, by the National Aeronautics and Space Administration of the United States, was originally a sphere 100 ft. in diameter, coated with vapour-deposited aluminium to provide radio wave reflectivity of 98 per cent up to frequencies of 4,000 Mc./s. The purposes of the experiment were, first, to check various systems of modulation for 'passive' communications, and, second, to investigate scintillations (which arise in the actual process of reflexion from the satellite), Faraday rotation, fading and polarization.

The experiment that we describe here involved communication using continuous wave transmissions only; it was performed on August 18 between Holmdel (New Jersey) and Issy-les-Moulineaux (France). A few days later a modulated signal was received at Jodrell Bank (Great Britain) with the big antenna.

A description of the equipment used by us is given elsewhere[1,2]. We shall give only the numerical characteristics of each component. The parabolic antenna (3·3 m. diameter) is not steerable automatic-

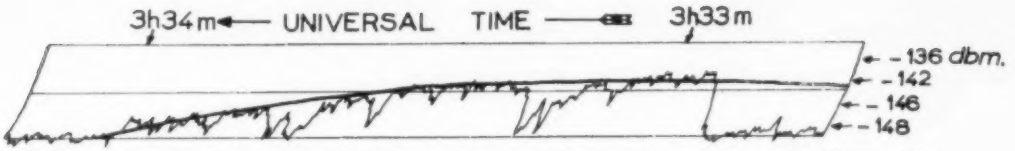

Fig. 1. Amplitude. The smooth curve is the theoretical one. The three troughs in the record are produced by errors in the frequency tracking

ally, so it was pointed to some definite direction before each pass. A flexible air-dielectric cable (100 ft. in length, 1·6 db. loss) was used to join the antenna to the parametric amplifier. The latter was operating in the degenerate mode, and gave an over-all receiver noise figure (measured with respect to 290° K.) less than 5 db. After mixing, the signal is fed to a phase-lock receiver[2,3] which reduces the effective band-width to about 20 c./s., but nevertheless is able to track variations of frequency produced by the Doppler effect. The threshold of the lock-in system is 7 db. above noise-level.

It is now easy to compute the power at amplifier input corresponding to the weakest signal which can be recorded. We have :

kTB =	– 161 dbm.
Noise figure	5 db.
Threshold	7 db.
Total $P_{min.}$ =	– 149 dbm.

This was in fact the figure measured with a calibrated signal generator (see Fig. 1).

Now we must compute the expected power P available at the focus of the antenna. This power is given by the following equation :

$$P = \frac{P_E G_E D_S^2}{16 l_1^2} \cdot \frac{\eta_r A}{4\pi l_2^2} \qquad (1)$$

in which P_E, transmitter power, is 9×10^3 W. ; G_E, gain of the transmitting antenna (estimated), is 44 db. ; l_1, distance between satellite and transmitter, is 4,000 km. ; l_2, distance between satellite and receiver, is 3,300 km. ; D_S, satellite diameter, is 30·5 m. ; A, area of receiving antenna, is 8·55 m.^{2} ; η_r, receiving antenna efficiency, is 0·47. With these data, equation (1) gives :

$$P = -136 \text{ dbm.}$$

However, three additional facts must be taken into account. First, the transmitted polarization was circular, whereas our primary feed was linearly polarized, thus losing 3 db. Secondly, the transmitter – satellite – receiver angle was 81°, which is very near the value 90° for which the scattering coefficient is reduced by 1·3 db. compared with the isotropic case[4] (for which we have assumed a cross-section of $\pi D_S^2/4$ rather than πD_S^2 as is assumed in ref. 4). Finally, we have to subtract the 1·6 db. loss of the cable.

Thus the maximum available power at the amplifier input is :

$$P_{max.} = -142 \text{ dbm.}$$

The difference between $P_{max.}$ and $P_{min.}$ is only 7 db., and, due to the great number of variables on which it depends, this very narrow margin can explain why, among the twelve trials that we made, only one was completely successful.

Results

In this particular trial, the antenna axis had an elevation of 15° ± 1° and an azimuth of 277° ± 1° (north to east). The signal was received for 1 min., from 3h. 32m. 56s. to 3h. 33m. 56s. U.T. This duration was about half what was hoped for, the discrepancy being due to instrumental difficulties. Because of the difference between the actual frequency of the transmitter (≃ 960·045 Mc./s.) and the value originally announced (960·050 Mc./s.), we wasted time looking for the signal around a false frequency.

The amplitude recording is given in Fig. 1. Noise is superposed above the monotonically decreasing signal. The lock-in system fell out of lock three times, and this fact explains the three troughs in the record.

Simultaneously, the frequency was printed every 2 sec. ; Fig. 2 gives the plotted results. The stability of our frequency standard was better than 1 part in 10^8 a day.

Comparisons

(*a*) *Orbital parameters.* In order to make some comparison with the theoretical prediction, we have computed the position, distance, and Doppler effect from 3h. 30m. to 3h. 35m. We assumed a Keplerian orbit, with both the right ascension of the ascending node and the argument of the perigee varying linearly with time. Orbital parameters were taken from the *Space Track Bulletins*, the accuracy of which was very poor in the early part of the life of *Echo* I. (For example, the time of nodal crossing for revolution No. 70, given in *Bulletin* 3, was 3h. 00m. 55s. ;

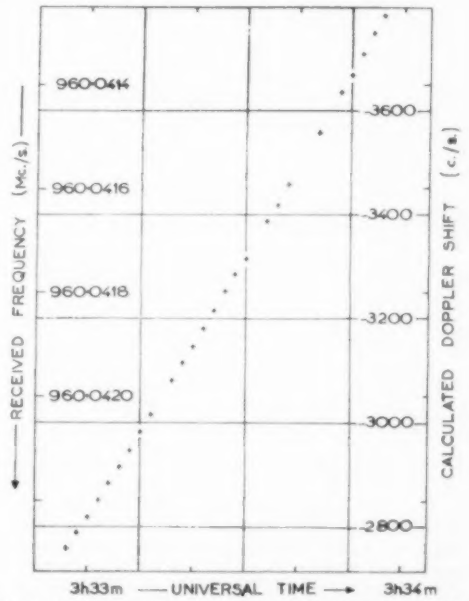

Fig. 2. Frequency. Only the measured points are shown : for comparison with the theoretical curve, see Fig. 3

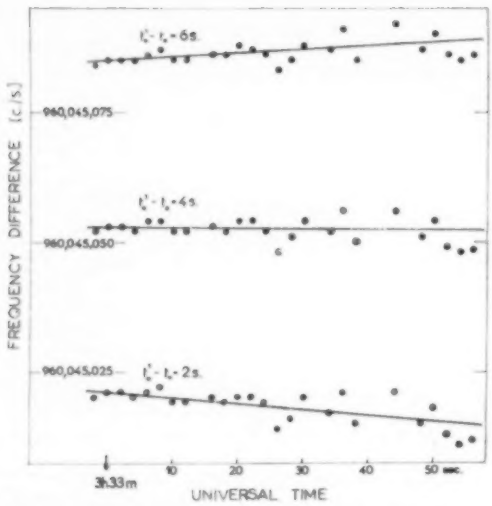

Fig. 3. Difference between the received frequency and the calculated Doppler shift, for three possible values of the time of nodal crossing. This difference is equal to the frequency of the transmitter. If this one had good stability, we must choose $t_0 - t'_0 = 4$s., and therefore $f_0 = 960{\cdot}045053$ Mc./s.

the same time, computed by extrapolation from *Bulletin* 4, was $t'_0 = 3$h. 00m. 31s., and the actual time was $t_0 = 3$h. 00m. 27s. $\pm$ 2s., as will be seen below.) We used for our computations the value t'_0, and corrected it, after the event, so as to obtain the best fit between the experimental and theoretical curves; this parameter is the most important one, since, for a duration of 5 min., the others give only a correction of a higher order.

The correction was made by two independent methods. The first method consists in comparing the computed Doppler curve with the observed one, and in seeking the time-shift that gives the best fit between them. Fig. 3 shows the difference between observed frequency and calculated Doppler shift for three possible values of $t'_0 - t_0$, namely, 2s., 4s. and 6s. We see that the values of 2s. and 6s. both imply a considerable drift of the transmitter frequency, of the order of 4 c./s./min. If, as we suppose, the transmitter frequency had in fact good stability (better than 10^{-8} a day), we must choose $t'_0 - t_0 = 4$s.

The second method consists in computing azimuth and elevation for the revolutions $n = 55, 56, 57, 80, 81, 82$, and in comparing them with the optical data (kindly communicated by Prof. P. Muller) for these revolutions; cloudy weather prevented Prof. Muller from observing on the particular night of our experiment.

For each revolution the curves fit well (within $\pm \frac{1}{2}°$) provided we suppose that there is a difference between the chosen time t'_n and the actual one (t_n). The differences $t'_n - t_n$ are plotted with respect to n in Fig. 4. A parabola drawn through the six points on this plot gives also $t'_0 - t_0 = 4$s. A parabola is involved because not only was an erroneous value chosen for the nodal period, but also this period was assumed to remain constant, whereas in fact it decreased with increasing time.

(*b*) ***Frequency curve.*** From the best fit of the two Doppler curves, we are able to compute the transmitted frequency:

$$f_0 = 960\ 045\ 053 \text{ c./s.}$$

The error Δf_0 in our measurement of f_0 can be calculated by assuming a maximum error $\Delta t_0 = \pm 2$ sec. in the time of nodal crossing. The slope of the frequency curve being about 1,050 c./s./min., the resulting Δf_0 is $\pm$ 35 c./s. as we can also see on Fig. 3, to which we must add the error of our frequency standard, so that:

$$|\Delta f_0| \leqslant 45 \text{ c./s.}$$

Examination of the points on Fig. 3 shows that their scatter is less than $\pm$ 4 c./s., and increases when the signal strength decreases (see also Fig. 1); this is a property of the phase-lock system. When compared with the scatter generally obtained in measurements of the frequency of satellite-borne oscillators[1], the present superiority of ground-located transmitters is obvious.

(*c*) ***Amplitude recording.*** Now, we will turn our attention to the amplitude recording. First the maximum strength of the received signals is -142 dbm., that is, it is very close to the predicted strength (within $\pm$ 1 db., which was the limit of accuracy of the calibration). Thus the reflexion seems to occur as in the idealized case; this implies a good sphericity of the balloon and no significant deterioration of the coating.

Secondly, the decreasing strength of the signal is fully explained by the passage of *Echo* I through the reception pattern of the antenna, thus excluding large fading of period less than $\simeq$ 1 min. This can be shown by computing azimuth and elevation and drawing the path as the satellite crosses the antenna pattern (Fig. 5). From this curve, we can deduce, with respect to time, the theoretical strength of the signal, and compare it with the experimental one; we do not make any allowance for the variation of l_1 and l_2, since their squared product has a negligible variation during 1 min. ($< 0{\cdot}2$ db.). The best fit (smooth curve of Fig. 1) is obtained when we suppose not only that $t_0 = t'_0 - 4$s., but also that our antenna beam was pointed towards B (Fig. 5) rather than towards A. This remains well within the accuracy of $\pm$ 1°. (A change from A to C would not affect very much the shape of the curve.)

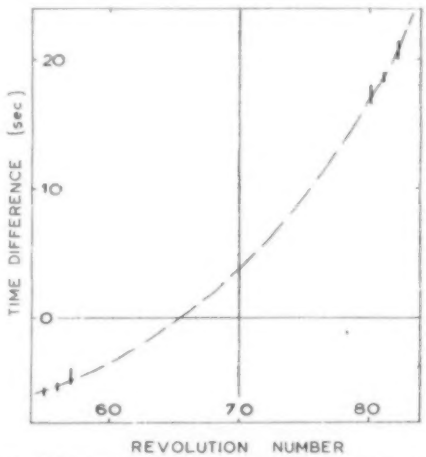

Fig. 4. Difference $t'_n - t_n$ between times of nodal crossing (t'_n is computed time; t_n is actual time), as deduced by comparing the theoretical calculations and optical measurements of the variations of azimuth with time. From this we conclude that, for the seventieth revolution, $t'_0 - t_0 = 4$s.

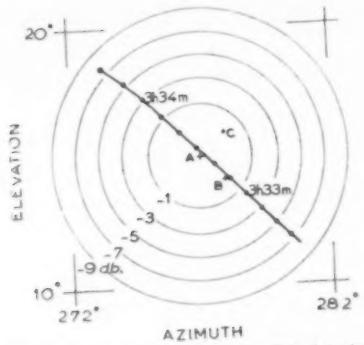

Fig. 5. Crossing of the antenna beam by *Echo* I (points every 10 sec.). *A* is the theoretical beam axis; *B* is the beam axis giving the best agreement with the experimental amplitude record. (The great circles are to be shifted in the same manner)

Fig. 5 also shows that, if we had had a receiving antenna with a beam width of 1° (as for the transmitting antenna at Holmdel), an error of tracking of ½° in angle, or of 5s. in time, would have given a loss of 3 db. (Losses of 5 db., because of lack of tracking accuracy, were found by another observer[5].)

Conclusion

This experiment, among many others, has proved the success of the *Echo* I project; in particular, it showed that the reflectivity of the coating is good, and that the received signals are free from rapid fading.

We have also seen the necessity of a big steerable antenna, in order not only to have better gain (say, 10 db. more), but also to avail oneself of the low temperature of the sky. But the beam-width of the antenna must not be too small, unless very good means of tracking are available.

From the point of view of communications, we must pay attention to the very unfavourable power balance in the use of a passive satellite; even with elaborate equipments, the band-width capabilities are limited to a few voice channels. But the simplicity of the balloon, together with the value of the many scientific results obtained with *Echo* I, argue for more elaborate tests of this kind.

Thanks are expressed to the National Aeronautics and Space Administration, which gave us much information, and to the Bell Telephone Laboratories, which supplied the transmissions to the balloon at the time when it was visible from both Europe and America.

We are indebted to Prof. P. Muller of Meudon Observatory for his optical observations, to Mrs. Epfelbaum for her constant help in the computations, and to the Direction des Etudes et Fabrications d'Armements for the loan of an electronic computer.

[1] Carru, H., Gendrin, R., and Reyssat, M., "Proc. of the First Int. Space Science Symp." (North Holland Pub. Co., Amsterdam, 1960).

[2] Carru, H., Gendrin, R., and Reyssat, M., *Toute la Radio*, No. 250 383 (1960).

[3] Jaffe, R., and Rechtin, E., *Inst. Rad. Eng. Trans. on Information Theory*, **1**, 66 (1955).

[4] Vea, T. H., Day, J. B., and Smith, R. T., *Proc. Inst. Rad. Eng.*, **48**, 620 (1960). See also comments about this paper in *Proc. Inst. Rad. Eng.*, **48** (September 1960) by Kennaugh, E. M., Morgan, S. P., Weil, H. (p. 1781), and Laugan, N. A. (p. 1782).

[5] *Aviation Week and Space Technology*, **73**, No. 8, 30 (August 22, 1960).

OBITUARIES

Prof. J. S. Rankin

DR. JAMES S. RANKIN, Freeland professor of natural philosophy in the Royal College of Science and Technology, Glasgow, died on November 16 in his sixty-seventh year.

Dr. Rankin joined the staff of the Natural Philosophy Department of the College in 1919, after a few years of postgraduate experience in industry, and except for the period 1943–45, when he was seconded to the University of Istanbul to occupy the chair of theoretical mechanics, his service to the College remained unbroken. He was appointed to the Freeland chair in 1942, and under his leadership the Department was a most stimulating place in which to work. His research interests extended over a wide field, his most notable work being concerned with the phenomenon of magnetostriction and, in particular, with attempting to explain the changes in the magnetostriction of steel resulting from various degrees of tensile over-strain.

One of his greatest achievements lay in the development of his course leading to the associateship of the College in applied physics. None of his predecessors had thought of the Department as other than an ancillary one for the engineering and other applied science courses in the College. In 1947 he set about his task of building up a school of applied physics which would have a recognized place in the higher aspects of technology. It was characteristic of his vision and determination that he succeeded, and young graduates from his school are now helping to bridge the gap that exists in industry between the 'pure' physicist and the engineer.

Among his other activities he was a governor of the West of Scotland Agricultural College, a member of the Vice-Chancellors' Committee on Hungarian Students and an ex-chairman of the Scottish Branch of the Institute of Physics and the Physical Society.

He had great gifts which he put to fine use in the service of the College. A devoted teacher, he will long be remembered by generations of students who came to know the warmth of his friendship.

J. W. SHARPE

Mr. E. C. Fieller

EDGAR CHARLES FIELLER, officer-in-charge of the Statistical Advisory Unit of the War Office, died suddenly on December 1. He was fifty-three years of age.

A prominent member of the Royal Statistical Society, he had served as a vice-president, several terms as a member of Council, as secretary, then chairman of the Research Section, and as a member of several committees. In 1960 the Society honoured him by the award of the Guy Medal in silver. He was for four years secretary of the British Region of the Biometric Society.

As a young man, after taking the Mathematical Tripos as a scholar of King's College, Cambridge, he was for a time a member of Prof. Karl Pearson's staff. This began an association with the School of Statistics at University College, London, which was

renewed in later years through his membership of the University board of studies and by his appointment as an examiner.

His subsequent experience with Messrs. Boots led him into the fields of market research and bioassay, in which he made several original contributions; one of these, a method for obtaining confidence limits for a ratio, is now well known as Fieller's Theorem.

Fieller served during the Second World War in the Operational Research Group of Fighter Command, R.A.F., part of the time as deputy to the officer-in-charge. After the War he joined the National Physical Laboratory in charge of the Statistics Group of the newly formed Mathematics Division. This Group was eventually transferred to the Ministry of Supply and, on the dissolution of that Ministry, to the War Office.

While on leave of absence from the Ministry of Supply, he fulfilled an assignment in Turkey for the Food and Agriculture Organization of the United Nations. There he conducted a training course in sampling methods which enabled a national survey to be made. He made many friends in Turkey, and his work there will have lasting effect.

In later years, when Fieller became a member of the International Statistical Institute, he made a particular point of seeking the acquaintance of the mathematical statisticians of other countries. These personal friendships must have made a considerable contribution to international understanding.

Fieller's published work of earlier years on probability problems and on bioassay was supplemented later by a paper on fiducial limits; in this, with his usual caution, he pointed out the consequences and paradoxes of a theory while reserving judgment on controversial points.

The pleasure he took in social contacts, his understanding of others and his fund of anecdotes, made him a good companion who will be missed in many places.

E. D. van Rest

NEWS and VIEWS

Entomology at the British Museum (Natural History): Dr. W. E. China, C.B.E.

Dr. W. E. China, who retires from his post as keeper of the Department of Entomology in the British Museum (Natural History) at the end of January, is a world authority on the insect order Hemiptera. During his thirty-nine years of service on the staff of the Department he has published more than two hundred papers on the structure, taxonomy, evolution and zoo-geographical distribution of this group of insects. After his retirement he intends to return to this work, which his administrative duties as keeper have interrupted. He became deputy keeper in 1945 and was largely responsible, under the keeper, Mr. N. D. Riley, for the rehabilitation of the Department of Entomology after the war-time bombing and the return of the National collection of insects, much of which had been evacuated. On the completion of the new building in 1951 he was concerned with the keeper in organizing the re-allocation of the entire entomological collection. He was appointed keeper in 1955. Dr. China is a foreign member of the Societas pro Fauna et Flora Fennica and corresponding member of the Société Entomologique d'Egypte. In 1959, he was appointed assistant secretary of the International Commission on Zoological Nomenclature.

Engine Research, Ministry of Aviation: Mr. Peter Lloyd, C.B.E.

Mr. Peter Lloyd has been appointed director general engine research and development, Ministry of Aviation, in succession to Mr. R. H. Weir, who is now director of the National Gas Turbine Establishment, Pyestock. Born in 1907, Mr. Lloyd went from Greshams School, Holt, to Trinity College, Cambridge, in 1925, where he took the Natural Science Tripos, Parts 1 and 2 (chemistry). After a year's research under Dr. (now Sir) Eric Rideal and a year in the German chemical industry, he was with the Gas Light and Coke Co. from 1931 until 1940 in charge of research on the industrial utilization of gas. In 1940 he joined the Royal Aircraft Establishment working first for Prof. G. T. R. Hill in the Air Defence Department at Exeter, and then in 1941 under Hayne Constant and W. R. Hawthorne in the turbine division of the Engine Department. With that team he transferred to Power Jets, Research and Development, Ltd., at Pyestock, in 1944, and soon after that body became the National Gas Turbine Establishment he became a deputy director. During the first part of this period his work was mainly concerned with combustion researches including studies of spontaneous ignition characteristics at high temperatures and the evaporation and burning characteristics of liquid fuel drops in high-speed air streams. Latterly he assumed a more general responsibility for Pyestock's research on aerodynamic, mechanical and metallurgical problems. Following two visits to Australia in connexion with the work of the Commonwealth Advisory Aeronautical Research Council, he was posted to Australia in 1960 as temporary head of the Ministry of Aviation Staff, during the period of recent negotiation with the Australian Government on space research. Peter Lloyd is a mountaineer who has taken part in three Himalayan expeditions, including the 1938 attempt on Everest, in the course of which he made the first comparative trial between open- and closed-circuit equipments. As a member of the Himalayan Joint Committee of the Alpine Club and the Royal Geographical Society he was closely concerned with the assaults on Everest, being responsible for the provision of the oxygen equipment used in the successful assault.

Monsanto Chemicals, Ltd.: Senior Scientist

Dr. I. S. Wilson has been appointed senior scientist to Monsanto Chemicals, Ltd. This appointment is part of a Monsanto scheme under which outstanding scientists on the company's staff may receive proper recognition of their status while continuing to specialize in scientific or technical work rather than accepting increased administrative responsibility. In his new capacity Dr. Wilson will be free to devote his whole time to research on effluent treatment and the microbiological breakdown of organic compounds.

The Leopoldina German Academy of Sciences : Elections

THE Deutsche Akademie der Naturforscher Leopoldina, Halle, recently elected the following new members, in the sections indicated : *Mathematics*, Prof. Emil Artin (Hamburg) ; Prof. I. R. Safarevic (Moscow) ; Prof. B. L. van der Waerden (Zurich). *Pathology and Anatomy*, Prof. Günter Bruns (Halle) ; Prof. Hermann Chiari (Vienna) ; Prof. Wilhelm E. Ehrich (Philadelphia) ; Prof. Andreas Werthemann (Basle). *General Biology*, Prof. Th. Dobzhansky (New York) ; Prof. Ake Gustafsson (Stockholm) ; Prof. Herman J. Muller (Bloomington) ; Prof. I. I. Schmalhausen (Moscow) ; Prof. Josef Straub (Cologne). *Zoology*, Prof. Robert Mertens (Frankfurt on Main).

Indian Institute of Science : Golden Jubilee

ON glancing through the Golden Jubilee Research Volume of the Indian Institute of Science (Bangalore, India, 1959), one is agreeably impressed by the diversity and range of scientific endeavour in India. As one would expect in a country developing its technology, applied science is given certain emphasis. There are articles on mineral flotation and extraction, turbomachines, silkworm nutrition, alloys, electronics research, soil fungi and concrete curing. But in more fundamental areas, too, research has been contributed —organic chemical syntheses, chemical kinetic investigations, derivation of expressions for compressible fluid-flow in the presence of magnetic fields, Hermite orthogonal functions and so forth. Science in India appears to have a character of its own—somewhat refreshing in this world of fading individuality. One article, for example, describes research on an Ayurvedic medicinal preparation called 'drakshasava'. This fermentation product has been of wide popularity in the country for a long time. It is claimed to cure a range of maladies like indigestion, cholic, insomnia, loss of appetite, phthisis and 'excessive debility'. An elegant microbiological evaluation of the drug was carried out. It was found only to support the growth of the micro-organism, *Saccharomyces cerevisiae*. Also, addition of vitamins and amino-acids did not stimulate growth. Except for sugars and trace elements, the drug did not contain essential growth factors—its only tonic effect appeared to be due to its alcoholic content. Pharmacological examination would be required to reveal the presence of very small quantities of ingredients which do cause the healing properties claimed. Nevertheless, establishing the use of microbiological technique in this way does provide scope for probing into these age-old medicines and disclosing their mysteries.

Mathematics in South Asia

THE report of the Second Conference on Mathematical Education in South Asia, held at Bombay in January 1960, has now been issued (Pp. xxiii + 205 ; Tata Institute of Fundamental Research, Bombay ; September 1960). Prof. Chandrasekharan, of the Tata Institute, presided over the Conference, and in his presidential address he urged the Conference not to think entirely of technical problems but to remember also that the great need in South Asia is the construction of a social and educational environment conducive to the growth of creative scholarship. In the report, the invited addresses are published in full, and the proceedings of the working parties are summarized. The accounts of the progress of mathematical education in Malaya, Indonesia, Thailand, Pakistan and Ceylon show what efforts have been made to implement the suggestions put forward by the first Conference (February 1959).

While emphasizing the vastness and complexity of the task, the addresses are optimistic, confident that in a short time significant progress towards national mathematical education culminating in vigorous schools of research will have been made. The other invited addresses, by mathematicians from Europe, North America and Asia, deal mainly with algebra and geometry, in the upper school, at the undergraduate-level, and in the first postgraduate year. Generally, stress is laid on the axiomatic approach and the basic importance of modern linear algebra, founded on a school knowledge of the elements of vector algebra and of sets of linear equations. Several of the addresses advocate an earlier introduction, in the universities, of modern abstract and general methods, on the grounds that students of to-day are not afraid of abstractions and can thus derive full advantage from an early acquaintance with general methods. The reports of the working groups preserve the flavour of lively and provocative discussions.

The Manchester Literary and Philosophical Society

VOLUME 102, 1959–60, of the Memoirs and Proceedings of the Manchester Literary and Philosophical Society well justifies Sir Cyril Hinshelwood's commendation of the Society in opening its new buildings in September (Pp. 81 + xliii. (Manchester : Manchester Literary and Philosophical Society, 1960.) 31*s*. 6*d*.). It includes the presidential address of Mr. C. E. Young on the growing importance of organo-metallic chemistry ; Dr. G. E. R. Deacon's Clayton Memorial Lecture on the scientific exploration of the oceans ; Prof. R. D. Waller's lecture on Danilo Dolci and his sociological work in Sicily and southern Italy ; Sir Gordon Sutherland's lecture giving some comparisons of British and American Universities ; and Prof. C. F. Carter's assessment of the practical value of the economist in government and in business in which he suggests that the Minister for Science should encourage a joint technical and economic appraisal of the opportunities for State-encouraged scientific development.

Irregularities in Spelling

BACKWARDNESS in the basic subjects has been the subject of considerable unfavourable comment by industrialists and others since the War. Among the causes of backwardness in reading, English spelling has long figured as an important factor. Spelling reform has been increasingly mooted since George Bernard Shaw's bequest for this purpose, and recently, the National Foundation for Educational Research in England and Wales in conjunction with the University of London Institute of Education agreed to undertake research into the alphabet form. An important preparatory step has been Dr. W. R. Lee's scientific study of the part played by spelling irregularity as a contributory cause of backwardness in reading. The results of his investigations have now been published under the title "Spelling Irregularity and Reading Difficulty in English" (Occasional Publication, No. 2 : Pp. i + 74. London : National Foundation for Educational Research in England and Wales, 1960. 10*s*.). It has been maintained that, if each sound were always represented by the same

letter, reading proficiency and reading habits would be achieved more easily. This study examines this hypothesis against experience at home and abroad, and follows this up with objective testing in experimental situations. The decisive conclusions should form an invaluable aid to teachers, administrators and all concerned with progress in education.

Foot-and-Mouth Disease in Madras

In the combined report of the King Institute of Preventive Medicine, Guindy, and the Government Analyst, Madras, for the year 1957–58, information is provided about the problem of foot-and-mouth disease in Madras State (Report of the King Institute of Preventive Medicine, Guindy, and Report of the Government Analyst, Madras, for the period from 1st April, 1957, to 31st March, 1958. Pp. i+121. Guindy, Madras: King Institute of Preventive Medicine, 1960). The conclusions of a committee set up to examine the position were that: foot-and-mouth disease is endemic in the whole Madras State and occurs year after year; the carrier state of the infected animals is quite long and lasts a year; it is not practicable to select virus-free animals for vaccination; and that with the facilities available at the Institute, every possible precaution has been taken to minimize the infection and its spread. The committee was of the opinion that controlled measures have become all the more important, as prophylactic vaccines against foot-and-mouth disease are not available in India. It is also not practicable to import vaccines from abroad as they are very costly and protection against local strains cannot be assured. The report contains detailed information about all measures taken to safeguard public health in the State.

A New Frog from Brazil

Among the specimens in a small collection of frogs sent to Coleman J. Goin of the University of Florida was a single individual of a striking little *Hyla*. It has been named *Hyla bokermanni*, n. sp. The specimen was an adult female and has small rounded vomerine tooth patches and small rounded dorsolateral stripes on a chocolate-brown background. It is perhaps most closely allied to *H. parviceps*, from which it differs in its smaller size, shorter legs, smoother skin, and in having a pattern of dorsolateral stripes as well as differences in detail of pattern of the thighs. From *H. microps*, which may also be a near relative, it likewise differs in its small size, shorter legs and in the pattern of dorsolateral stripes (*Ann. Mag. Nat. Hist.*, **2**, No. 24; December 1959).

Fecundity of the Nile Mormyrid, *Hyperopisus bebe* (Lacepede)

Attention has recently been directed to the importance of the fish fauna of the Nile as a valuable source of protein food. Experimental stations have been constructed for the breeding of some of the economically important species of the Nile fishes. Work on the fecundity of the Nile fishes would, therefore, be of importance for such projects and for a general control scheme for the maintenance and increase of the productivity of the rivers, but except for the observations made by Kenchington in 1933 on the fecundity of the Nile perch *Lates niloticus* (Linnæus 1762) no one has previously examined this problem. G. Nawar has now investigated the fecundity of *Hyperopisus bebe* (Lacepede) (*Ann. Mag. Nat. Hist.*, **2**, No. 22; October 1959). The fecundity, defined as the number of eggs produced by the female during the breeding season, was determined through the study of 62 females. It was found to vary in the range 2,030–33,060, provided that the fecundity is calculated on the basis of counting the whole number of ova per ovary. A correlation between fecundity, length and weight of the specimen was observed.

New Virus isolated from Culicine Mosquitoes

During April 1958, an outbreak of febrile illness of unknown ætiology occurred among the residents of Germiston, a town near Johannesburg. As it was considered that this outbreak might have been due to an arthropod-borne virus, mosquitoes were collected with the intention of isolating the causal agent. In the centre of Germiston, which is a highly industrialized town, is a small lake with an adjoining golf course and park. On the edge of the lake is a dense reed-bed with a heronry in which large numbers of cattle egrets (*Bubulcus ibis*) roost and breed. At the time the mosquito collections were made, the heronry contained hundreds of fledgling cattle egrets. Associated with the reeds and surrounding trees were lesser numbers of black-headed herons, sacred ibises, coots, moorhens, reed warblers, weavers and doves. Mosquitoes were collected on the edge of the lake in proximity to the reeds. From *Culex* (*Neoculex*) *rubinotus* Theobald mosquitoes collected at Germiston, three virus strains were isolated. Two of these strains were identical and have been shown to belong to the Bunyamwera group of arthropod-borne viruses. B. M. McIntosh, R. H. Kokernot and H. E. Paterson report in the April issue of the *South African Journal of Medical Science* that they have now isolated a third virus strain which has been shown to be unrelated immunologically to many arthropod-borne viruses. Accordingly, the name Witwatersrand virus has been proposed, which has reference to the geographical area where the mosquitoes were collected and from which the agent was isolated.

Essay Competition on Corrosion Science

The Corrosion Group of the Society of Chemical Industry is organizing a competition designed to encourage persons who are still in the early stages of their career to take an interest in corrosion science. The competition will take the form of an essay, and persons aged not more than 30 years are invited to present an essay or paper on any aspect of corrosion of metals and its prevention. A prize of 25 guineas will be awarded. The closing date for receipt of entries is March 31, which should be addressed to Corrosion Group Essay Competition, c/o Society of Chemical Industry, 14 Belgrave Square, London, S.W.1, whence further information can be obtained.

"Effect of Corona Discharges on Polyethylene"

Referring to the communication under this title published in *Nature* of November 12, 1960, p. 577, Mr. L. R. Hougen states: "Further work has revealed that the identification of the alcohols in the gas chromatogram (Fig. 1) is incorrect, due to false labelling of the marker compounds, which was beyond my control. A correct interpretation of the gas chromatogram indicates that the distribution of breakdown products between the different carbon numbers is statistical, and that the largest peak represents C_{10} secondary alcohols, which suggest that a free-radical mechanism may play an active part in the breakdown reactions".

The Night Sky in February

NEW moon occurs on Feb. 15d. 08h. 11m. U.T.; full moon does not occur this month. The following conjunctions with the Moon take place: Feb. 2d. 07h., Regulus 1° N.; Feb. 13d. 06h., Jupiter 4° S.; Feb. 13d. 07h., Saturn 3° S.; Feb. 18d. 11h., Venus 7° N.; Feb. 22d. 20h., Aldebaran 0·2° S.; Feb. 24d. 17h., Mars 8° N. Jupiter is in conjunction with Saturn on Feb. 18d. 15h., Jupiter 0·2° S.; this phenomenon occurs once every twenty years, and on this occasion the approach is unusually close, but conditions for observation are unfortunately not favourable. There is a total eclipse of the Sun on February 15, visible as a partial eclipse at Greenwich. The eclipse will be total along a track passing through southern France, northern Italy, the Balkans and parts of the U.S.S.R., where there will be a maximum duration of 2m. 45s. Seen from Greenwich, the partial eclipse begins before sunrise, attains its maximum phase of 0·93 at 7h. 42m., and ends at 8h. 47m. This is the largest eclipse to be seen from Greenwich since 1927 and until 1999. Mercury will be visible as an evening star during the first half of the month. Venus is an evening star, favourably placed for observation. Venus sets at 21h. 20m., 21h. 45m. and 21h. 50m. on February 1, 15 and 28, respectively, more than 4 hr. after the Sun. During the month its distance from the Earth decreases from 63 to 44 million miles, the visible portion of the apparent disk from 0·499 to 0·315, and its stellar magnitude from −4·1 to −4·3. Mars sets at 6h. 00m., 5h. 10m. and 4h. 25m. at the beginning, middle and end of the month, respectively. Mars is very conveniently situated for observation. It is at a distance of 80 million miles from the Earth on February 15, and its stellar magnitude is −0·1. Jupiter and Saturn are too close to the Sun for easy observation; they are only observable in the twilight before sunrise. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Feb. 10d. 5h. 19·7m., 24 Sco. (*R*); Feb. 22d. 21h. 18·8m., 89 Tau. (*D*); Feb. 23d. 18h. 01·6m., 111 Tau. (*D*); Feb. 26d. 22h. 19·1m., 5 Cnc. (*D*). *D* and *R* refer to disappearance and reappearance, respectively.

Announcements

DR. RUDOLF L. MÖSSBAUER has been awarded the 1960 Research Corporation Award by the California Institute of Technology and Research Corporation for his work on the production and detection of gamma rays. Dr. Mössbauer is at present on leave of absence at the California Institute of Technology from the Institute of Technical Physics, Munich.

AMONG the recent changes in administration and organization of the Akers Research Laboratory, Imperial Chemical Industries, the following appointments are announced: Dr. P. W. Brian, to become associate research manager of the Pharmaceutical Division and to be in general charge of the Laboratory; Dr. J. Chatt, to become group manager of the Heavy Organic Chemicals Division. Dr. Chatt will continue in charge of the Organic Chemistry Department.

THE Automatic Programming Information Centre, Brighton Technical College, is organizing a course in Algol 60 during April 5–6. Further information can be obtained from Richard Goodman, Automatic Programming Information Centre, Brighton Technical College.

THE annual general meeting of the Scottish Branch of Aslib is to be held at the National Engineering Laboratory, East Kilbride, on February 3. Further information can be obtained from the honorary treasurer, J. R. K. Pirie, M.E.R.L. (Aslib), East Kilbride, Glasgow.

THE Institute of Physics and the Physical Society is organizing a conference on "The Crystal Structures of Organic Compounds" in the Chemistry Department of the University of Glasgow during April 6–7. Further information can be obtained from the Secretary of the Institute of Physics and the Physical Society, 47 Belgrave Square, London, S.W.1.

THE Faraday Society is organizing an informal discussion on "Mechanisms of the Gas-Phase Reactions of the Halogens and their Compounds" at the Chemistry Department, University College, Cardiff, on March 28. The programme will be divided into two sections: (*a*) Oxidation processes; (*b*) reactions of elementary halogens. Further information can be obtained from Dr. J. H. Thomas, Chemistry Department, University College, Cathays Park, Cardiff.

A CONFERENCE is being organized by Research and Control Instruments, Ltd., on "X-ray Analytical Methods" at the Department of Geology, University of Manchester, during March 20–24. Further information can be obtained from the Conference Secretary, Research and Control Instruments, Ltd., Instrument House, 207 King's Cross Road, London, W.C.1.

THE Institution of Mechanical Engineers is organizing a symposium on "User Experience of Large-Scale Industrial Vacuum Plant" at the Institution during March 1–2. The symposium is being sponsored by the Joint British Committee for Vacuum Science and Technology. Further information can be obtained from the Secretary of the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1.

THE Department of Scientific and Industrial Research is organizing a two-day national conference on "Science and Industry—the Problem of Communication", which is to be held at the Brangwyn Hall, Swansea, during April 18–19. Further information can be obtained from the Press Officer, Central Office of Information, Park Place, Cardiff, or the Department of Scientific and Industrial Research Press Office, 5–11 Regent Street, London, S.W.1.

AN all-day meeting of the Welsh Soils Discussion Group will be held in the Department of Agricultural Chemistry, University College of North Wales, Deiniol Road, Bangor, on February 8, to consider "Glaciation in Wales as related to Soil Profile Development". Further information can be obtained from D. F. Ball, The Nature Conservancy, Penrhos Road, Bangor, Caernarvonshire, or James A. Taylor, Department of Geography, University College of Wales, Alexandra Road, Aberystwyth.

ERRATUM. We regret that the title of the communication by J. S. Machin and D. L. Deadmore in *Nature* of January 21, p. 223, is incorrect; it should read, "Thermal Stability of $TiOF_2$". Throughout the text the formula '$TiOF_2$' should be substituted for 'titanium dioxide', except where the latter is defined as anatase and in the third paragraph from the end.

THE NUFFIELD UNIT OF TROPICAL ANIMAL ECOLOGY

IN the past few years biologists in general have come to realize the great importance of an intensive study of tropical animals, their ecology, and the conditions of their existence. It is not merely that tropical Nature is a source of invaluable scientific information which is in danger of vanishing through the changing of the face of the Earth by man. It is also that the fauna of tropical nature reserves gives us an opportunity of determining with precision the factors that control both the physiology of individual animals and the size of their populations under conditions as yet relatively unspoilt. We need critical analysis of ecological factors, aided by laboratory investigations, together with the physiological study of what makes tropical species so much more efficient for the production and maintenance of animal substance than species imported from temperate latitudes.

It was with studies of this sort in mind that, on the initiative of Sir Landsborough Thomson and the Zoological Society, in discussions with the Director of the Nuffield Foundation, a proposal to form a Unit of Tropical Ecology was developed and placed before the Foundation. The Foundation has accepted the proposal and given it most generous and substantial support. The University of Cambridge has readily accepted the proposal that the Unit should be controlled from the University.

The immediate objective of the Unit is to maintain one senior and one junior research worker in tropical ecology to work at the Queen Elizabeth National Park, where the Trustees of the Uganda National Parks already have a small field station. The work of the Unit will, however, be controlled from the University of Cambridge, by a Committee under the honorary chairmanship of Prof. C. F. A. Pantin. The Committee will include representatives from the University of Cambridge, the Nuffield Foundation, the Zoological Society of London and the Trustees of the Uganda National Parks. It is an important part of the scheme that, while the field work will be done in Uganda, the research workers will spend substantial periods planning their work and studying their observations in the Zoological Laboratory at Cambridge. It is hoped that as the scheme develops other research workers will be encouraged to attack problems in Uganda, and also that it will lead to young research workers engaged on such problems coming to work at Cambridge. The authorities of Makerere College have already shown great interest in the Unit.

The Committee will be holding its first meeting early this year to consider staff appointments, and sent Dr. Hugh B. Cott to visit the field station in December and to make a first report. The promoters of the scheme have great hopes that the Unit will lead not only to important work on the ecology, physiology and environmental relations of tropical animals, but also to a greater contact between research workers in Britain and Uganda than has hitherto been possible: further, that the attack on animal ecology may later develop into a broader project, including plant ecology and the study of micro-organisms.

BRITISH COMMUNICATIONS SATELLITE PROGRAMME

IN replying for the Government in an adjournment debate in the House of Commons on December 21 on a British communications satellite programme, which had been opened by Mr. A. Neave, Mr. G. Rippon, the Parliamentary Secretary to the Ministry of Aviation, welcomed the practical approach of speeches in the debate. Previously he had pointed out that communications satellites involve the use of a powerful launcher and that the project is thus distinct from the programme based on *Skylark*, the giant programme in the United States, and also the Preparatory Commission set up to study the possibility of establishing a European space research organization. Both British and American experts are confident that the purely technical problems can be solved within the next few years, and Post Office and Ministry of Aviation scientists and engineers are already carrying out joint work on the design of ground stations and satellites as well as of overall system design. This work is concerned with both technical and economic aspects of satellites. While the co-operation of industry will be sought at the appropriate stage, he did not think that there is anything to be gained by setting up a space communications committee at Cabinet level, as suggested by Mr. Neave.

Mr. Rippon pointed out that many different types of system have been proposed, but experts, both in the United States and in Britain, to-day appear to favour a system using active satellites which will carry radio receivers and transmitters, thus receiving, amplifying and re-transmitting signals instead of just reflecting. He promised to bear in mind what Mr. D. Price had said as to the possibilities of such a system.

The study of system design includes that of the type of orbit to be chosen for the satellites, which could be circular or elliptical, close to the Earth or far away. It is possible to choose a particular circular orbit for a satellite at about 22,000 miles from the Earth, and three such satellites could be so placed that one at least is visible and potentially available for communication purposes from every country in the world, except for certain limited areas near the poles. This system has some disadvantages, and it may well be better to have a larger number of satellites in closer orbit, for example, a dozen or two satellites at 5,000 or 6,000 miles, or 50 at 2,500 miles. Whatever orbit is chosen, there are formidable difficulties, and the technical problems to be overcome make estimates of cost necessarily speculative at this stage. Reliable information on the useful life of a

satellite is required, and this can only be obtained by experiment, for which the most promising area is the North Atlantic. Mr. Rippon hoped that such tests will take place in the next year or so, and said that Britain envisages putting two or three satellites into polar orbit. He also said that Britain is aiming at about 1,000 channels for an active satellite, but there is really no limit to the number of channels for a passive satellite.

Meanwhile, Britain will continue with construction of the submarine cables to provide for the communication needs of the Commonwealth, for which a programme, costing between £35 and £40 million, has been approved, covering the cable between Canada and the United States in 1961 and Canada and Australia in 1966. The United Kingdom's share will be less, and it may be found that cable and satellite communications are complementary indefinitely. As regards a launcher, the Government has kept in being those aspects of the *Blue Streak* project which can be of use in developing a satellite launcher. The scientific and technological skills have been preserved, and the teams necessary to develop a satellite launcher retained: should such a launcher be developed, what Britain has done and is doing would enable her, or any other participating country, to formulate a programme and put satellites into orbit within the next five or six years. We have already concluded that, if a heavy satellite launcher were to be developed outside the United States or the U.S.S.R., there are substantial advantages for all concerned in doing so in co-operation with the Commonwealth and Europe. Mr. Rippon directed attention to the fact that Britain is keeping in close touch with Australia and Canada and other members of the Commonwealth, and, if the *Blue Streak* proposals are carried to completion, the facilities at Woomera will be used. The Government has also had lengthy discussions with the French Government on the joint development of a satellite launcher based on *Blue Streak*, and these have gone well. It is intended to ask interested countries to join in a conference early in 1961, and in the meantime individual countries are being invited to send their experts here for discussions and to judge for themselves the technical soundness of the British proposals.

FUTURE OF THE COLONIAL AND THE COMMONWEALTH RELATIONS OFFICES

IN answer to questions in the House of Commons on December 13, the Prime Minister said that he is considering, in consultation with the Commonwealth and Colonial Secretaries, the recommendations regarding the future of the Colonial Office and the Commonwealth Relations Office made by the Select Committee on Estimates, and that the subject will be discussed with other Prime Ministers of the Commonwealth at their Conference to be held during March. Meanwhile, the problem of fusion is being studied to see whether some of the advantages of co-ordination can be secured without the disadvantages of combining relations with independent and dependent members in a single Office. In replying for the Government in a subsequent debate in the House of Commons on December 19, on the Select Committee's report, the Colonial Secretary, Mr. Iain Macleod, said that it is clear that the present policy of leading the dependent territories to full independence as early as is compatible with their educational, political and economic development is bound before long to lead to a stage when there is no longer justification for a separate Office, headed by a Secretary of State, to conduct the relations with the few small remaining dependencies. A Commonwealth Service is another matter, and the preference of the independent countries for independent recruitment and for local officers rather than expatriates destroys the basis of a Commonwealth Service. Meanwhile, the burden of work falling on the two Secretaries of State is too great for a merger to be practical for at least a year or two ahead. Moreover, territories which are reaching independence during the next few years will continue to require in their services expatriate officers in professional, technical and administrative posts, and the supply of such officers concerns both the Colonial Office and the Commonwealth Relations Office.

Ultimately, Mr. Macleod thought, the solution might well lie in the bringing together of the two Offices as the Select Committee recommends, but this is not yet practical politics. Meanwhile, the Government has initiated a study of the possibility of creating a joint Department under a Minister responsible to the Colonial Secretary, the Secretary of Commonwealth Relations and the Foreign Secretary to handle under a single direction many of the forms of technical and advisory assistance which Britain provides to overseas countries whatever their status. Mr. Macleod stressed the importance of the contribution which Britain can make in technical assistance through the experience and knowledge of its men and women. It is accordingly proposed to defer consideration of the Select Committee's proposal for a Commonwealth Advisory and Technical Service pending the result of this examination. Mr. Macleod concluded with a warm tribute to the work of the Colonial Service and to the achievements of what is described as British colonialism. Britain can no longer offer many of the members of the Overseas Service the full cover which they have earned, and it is the Government's duty to ensure that everything possible is done to minimize any consequent hardship. He claimed that Britain has the finest organization in the world for providing professional and technical assistance to underdeveloped territories, and the men and women of the Overseas Service and their predecessors have a record of service of which all should be proud.

Mr. Macleod's tribute to the Colonial Service and his concern for the future of the men and women of the Overseas Service echoed what had been freely expressed in the debate, but although there appears to be widespread support for the merger of the two Offices caution was urged from both sides of the House. There is clearly concern that very big changes will be required in the Commonwealth Relations Office itself before it is fit to deal with the new situation and the needs of the newly independent members of the Commonwealth. In fact, there is much greater confidence in the ability of the Colonial Office to provide the advice, the experience, the skill and techniques that will still be required.

HYDROLOGY IN GREAT BRITAIN

FOR several decades a minority of enthusiasts have pressed on the Government the need for an improved hydrological service in Great Britain. Official recognition of this need was recorded recently in the annual report of the Advisory Council on Scientific Policy, where attention was directed to the fact that Great Britain remains weak in research on hydrology. Yet another warning of coming difficulties in meeting demands on water supply in Great Britain was recently given by Sir Herbert Manzoni in his presidential address to the Institution of Civil Engineers. The position shows every sign of becoming serious in a few years time, and in terms of research a great number of problems are involved throughout the whole of the hydrological cycle; ranging more especially from the effects of vegetation on catchment areas to problems of water use, such as waste by consumers and losses from leaks in water mains. Coincident with these warnings and confirming the need for water conservation and a national water policy, the country has had to endure extensive flooding as a result of one of the wettest autumns on record.

Faced with such difficulties it is pleasing to record some recent advances in hydrological research in Great Britain which it is hoped augurs well for future action. The Surface Water Survey of the Ministry of Housing and Local Government now seems well established and is producing an annual report with admirable regularity. The latest edition[1] covers the water year 1958–59, and includes the flow records of 188 gauging stations of which 19 appear for the first time. There is every indication that this number will rise still further in the next issue as many new stations have recently been established and are now in process of calibration. The water-year covered by the 1958–59 volume is of particular interest as it records the effects of the severe drought of the summer of 1959. The rainfall over England and Wales during the period from May to September was only half the long average for 1916–50, and was probably the lowest for more than 230 years. By the end of September many rivers reached new all-time record low levels; indeed, some dried up altogether.

In addition to the responsibility for an annual return the Surface Water Survey was also charged in 1959 with the preparation of hydrological surveys of selected basins. This duty arose from the recommendations of the Sub-Committee on the Growing Demand for Water[2] that hydrological surveys of river basin areas should be carried out, initially in those areas where the expected surplus of water supply over demand is lowest. Two surveys have now appeared: a few months ago the River Great Ouse Basin (Hydrometric Area No. 33)[3] was published, and more recently the River Severn Basin (Hydrometric Area No. 54)[4] has become available. These reports are notable steps forward in the study of Great Britain's water resources, water use and management. There are still, however, another hundred hydrometric areas to be considered if the whole country is to be covered so that a national assessment of the problem now confronting Great Britain may be made.

Both the surveys which have so far appeared attempt a coverage of all the aspects of the hydrological cycle. There is a general study of the area, population, rainfall, geology, principal rivers and hydrology in the first part of each survey. In the second part the hydrometric area is broken down into five geographical sections in each of which the topography, population, hydro-geology, meteorology, gauging stations, water quality, pollution, navigation, flood protection, irrigation, water use and potential water resources are systematically considered. These descriptive paragraphs are followed in each area by details, both in list and map form, of abstraction of water by public undertakings and by industry, discharges of water by public authorities and by industry, and a water balance sheet. These sections are packed with valuable data which will be of immense value to those concerned with the use of the respective water resources. The third part of each report has a summary and forecast of possible future trends.

The River Ouse survey showed that the basin is one of the driest in Great Britain, and with very few natural sites for storage reservoirs available the continued development of surface water is limited. The main problem that gives cause for anxiety is the rising demand for irrigation water. The chief hope for the future lies in a greater exploitation and at the same time proper management of the ground water resources: these appear to be considerable in some parts of the basin.

The River Severn survey, while following the pattern of the River Ouse survey, is more ambitious in that estimates are given ahead to 1980. Covering an area of 4,410 square miles the River Severn Basin reaches from Rugby to Lake Vyrnwy and from Shropshire to the Bristol Channel. It is the largest river basin in Great Britain and has a mean run-off of 2,200 million gallons per day. At present the river basin supports a total water use of 737 million gallons per day for almost 2 million people: of this some 121 million gallons per day are permanently abstracted for use in the area and another 43 million gallons per day are exported without serious consequences as to the remaining quantity or quality of the river water even during prolonged periods of dry weather. The report suggests that maybe another 10 million gallons per day could be taken without noticeable effects during a drought, but that the abstraction of an additional 50 million gallons per day would certainly produce difficulties, while an additional abstraction of 100 million gallons per day might at times dry the river above Bewdley and produce objectionable conditions downstream.

Proposals have already been made by public water undertakings for the construction of works capable of abstracting an additional 100 million gallons per day, so that total abstractions for the mid-1960's could amount to 260 million gallons per day, on top of which has to be added increased direct abstraction by industry and by agricultural interests for irrigation. By 1980 it is anticipated that abstractions could rise to 370 million gallons per day with possibly 64,000 acres under irrigation.

The report makes it clear that these increases can only be achieved by additional storage, controlled use, and a policy of integrated river basin development. The authors reject the extensive use of conventional storage reservoirs and pumped storage schemes and come down in favour of regulating reservoirs, with which, it is maintained, an additional 250 million gallons per day could be guaranteed, an adequate flow in the Severn preserved at all times, much agricultural and urban land protected from flooding, and up to 64,000 acres irrigated in times of drought.

W. G. V. Balchin

[1] Ministry of Housing and Local Government, and Scottish Office. *The Surface Water Year-Book of Great Britain, 1958–59: Hydrometric Statistics for British Rivers, together with related Rainfalls, for the year ended 30th September, 1959.* Pp. xiv+92. (London: H.M. Stationery Office, 1960.) 17*s.* 6*d.* net.

[2] Central Advisory Water Committee. Sub-Committee on the Growing Demand for Water. Second Report. Pp. 5. (London: H.M. Stationery Office, 1960.) 6*d.* net.

[3] Ministry of Housing and Local Government. *River Great Ouse Basin: Hydrological Survey (Hydrometric Area No. 33).* Pp. 100+9 folding maps. (London: H.M. Stationery Office, 1960.) 12*s.* 6*d.*

[4] Ministry of Housing and Local Government. *River Severn Basin: Hydrological Survey (Hydrometric Area No. 54).* Pp. iv+134. (London: H.M. Stationery Office, 1960.) 17*s.* 6*d.* net.

HYGIENE AND PLANT PROTECTION

THE chemical means of plant protection and problems of hygiene have been reviewed by L. I. Medved, director of the Kiev Institute of Labour Hygiene and Occupational Diseases, in a recent issue of *Impact of Science on Society* (10, No. 4, 1960).

The systematic fight against pests and diseases of cultivated plants is not only of great economic importance, but is also socially significant. It has been calculated that the loss of food and technical crops on the farms of the United States due to pests, fungoid diseases and weeds amounts to about 11,000 million dollars a year. Similarly it has been shown that implementation of measures for the protection of plants against pests, diseases and weeds would make an additional quantity of agricultural produce, valued at about 54 billion roubles, available in the U.S.S.R. While the quantity of pesticides produced and employed in agriculture by either of these two countries is considered greater than by any other, and, if they possess enormous reserves for increasing agricultural produce as a result of further use of pesticides, the same opportunities exist in other countries.

The beneficial aspect of the use of poisonous chemicals in agriculture is evident, but the social effects should not be overlooked. All, or almost all, the chemicals employed are biologically active, and in some cases are potentially poisonous for human beings. Investigations by Soviet scientists have shown that the prolonged action on the human organism of various chemical substances, even in insignificant quantities, may lead to a fall in the reactivity of the organism and to a rise in susceptibility to other diseases. In such cases, acute and chronic intoxication does not occur, but a general high level of morbidity is noted.

The problem of the carcinogenic effect of certain chemicals requires special attention. There are indications that carbolineum and its preparations, employed in a number of countries, contain a carcinogenic impurity (benzpyrene). There have been reports on the carcinogenic properties of *iso*-propylic ether of 3-chloro-phenylcarbamic acid, applied as herbicides in a number of countries. Concern is felt in the United States about the carcinogenic properties of certain organochloric insecticides.

The danger of chemicals to public health does not lie only in the possibility of accidents (acute intoxications). The chief danger to the health of the population lies in the prolonged chronic action of certain preparations inducing pathological states which are not ordinarily diagnosed as intoxication. Considerable data have been presented by American investigators on the rise in the incidence of diseases of the liver and gastro-intestinal tract, and of cardiovascular and nervous diseases among the population of the United States and a number of other countries, as a result of the extensive use of DDT and other organochloric compounds.

The duty of toxicology as the science of the toxic properties of chemical substances is not only to determine the lethal doses of one substance or another, but also to ascertain the possibilities of its chronic effect on the human organism over a prolonged period of intake in small quantities. A preparation which is widespread throughout the world, like DDT, has only a slightly toxic effect on the organism in a single dose, and the probability of poisoning with a lethal outcome is insignificant. When taken into the organism in various ways, however, DDT accumulates in the fatty tissues and is retained in them for a long time. Even in slight quantities, DDT acts very slowly, but destructively, on the organism. The increase in liver disease incidence observed in many countries is to a certain extent due to the intensified use of DDT and other organochloric insecticides.

Investigations conducted in the toxicological laboratory of the Kiev Institute of Labour Hygiene and Occupational Diseases have shown that DDT, chlorindane, hexachlorane, heptachlor and other organochloric preparations, even when taken into the organism in small quantities, accumulate in it and afterwards give rise to various diseases. The investigations of the Ukrainian Institute of Nutrition have shown that, if a plant is treated with DDT during the period of fructification, the preparation is retained for a long time in the fruits. When milch cows are given repeated treatment to combat blood-sucking insects, DDT is eliminated in the milk during a period of over three months in quantities endangering the health of people consuming the milk. DDT does not break down under natural conditions or as a result of cooking. On the basis of the results obtained in these investigations, the State Sanitary Inspection of the U.S.S.R. has adopted an enactment prohibiting the treatment of plants with DDT during the period of fructification and providing for other restrictions.

GAS CHROMATOGRAPHY: DEFINITIONS AND RETENTION PARAMETERS

LEADING workers in gas chromatography soon realized that published retention data would have much greater value if they were reported in a manner which made quantitative comparison possible, and in 1956, at the first committee meeting of the Gas Chromatography Discussion Group of the Institute of Petroleum Hydrocarbon Research Group, a sub-committee was formed to consider recommendations on presentation of data. Although differences between the views of this sub-committee and American workers were settled early in 1958, it was evident that international agreement was desirable, and approaches to the International Union of Pure and Applied Chemistry resulted in the formation of a Task Group to consider the matter. In addition to presentation of data, the Task Group also considered nomenclature, its terms of reference being to encourage the use of established conventions provided they were consistent with accepted theory, to select a single term where several existed, and to eliminate ambiguity of definition. The preliminary report of the Task Group was made available to the Discussion Group early in 1960 and has now been published in *Pure and Applied Chemistry*, the journal of the International Union.

At an informal symposium held at the University of Liverpool on October 21, where the Discussion Group was welcomed by Dr. G. Skirrow, the International Union of Pure and Applied Chemistry recommendations were discussed, and papers on alternative methods of presentation were read. The chair for the morning session was taken by Mr. C. S. G. Phillips and for the afternoon session by Mr. R. P. W. Scott.

After reviewing the historical background and acknowledging a valuable contribution to the work by the Groupement pour l'Avancement des Méthodes Spectrographiques, Dr. D. Ambrose, chairman of the International Union Task Group, discussed some of the points which had been considered in drawing up the recommendations summarized below.

The technique of gas chromatography is divided into gas–liquid and gas–solid, depending on whether separation is effected by partition or adsorption. Definitions are given for the following terms: sample injector, column (solid volume, liquid volume and interstitial volume), detector (differential and integral), carrier gas, liquid phase, solid support and active solid. In gas–liquid chromatography the stationary phase comprises the liquid phase without solid support, and in gas–solid chromatography the stationary phase is the active solid. On the chromatogram, base line, peak, peak base, peak area, peak height, peak width and peak width at half-peak height are defined and illustrated. The Martin and James pressure gradient correction factor is designated j. Uncorrected and corrected (factor j applied) retention volumes measured from the point of injection are respectively V_R and $V°_R$. The uncorrected retention volume for a non-absorbed gas is termed gas hold-up, V_M. The adjusted retention volume $V_R - V_M$ is designated V'_R and becomes net retention volume V_N when the correction factor j has been applied. These parameters are reported at the column temperature. Specific retention volume V_g is the net retention volume per gram of liquid phase corrected to the volume at 0° C.

Retention data should be published on an absolute basis or relative to a pure solute for which an absolute value is known at the operating temperature, and, wherever possible, the variation with temperature should be reported. Relative retention r of two components is given by:

$$r_{1,2} = \frac{V_{g_1}}{V_{g_2}} = \frac{V_{N_1}}{V_{N_2}} = \frac{V'_{R_1}}{V'_{R_2}} \neq \frac{V_{R_1}}{V_{R_2}}$$

The theoretical plate value n of a column is used to express column performance (previously referred to as column efficiency), and peak resolution is given by twice the difference between retention (in volume, time or distance) divided by the sum of the peak widths in the corresponding units. Sample size, method of injection, and detector dead volume are factors which can affect the values obtained for retention parameters, column performance and resolution unless corrected for. The recommendations are preliminary and the Task Group is to exist for at least another two years; comment and suggestions will be welcomed by Dr. D. Ambrose (National Chemical Laboratory, Teddington, Middlesex, England).

Mr. G. R. Primavesi (Distillers Co., Ltd.), expressing the views of an analyst on the presentation of data, maintained that whatever terms were used they should be relative as well as absolute, and that chart distance took pride of place over time or volume. The theoretical treatment of Martin and James was adequate, although the analyst had no need for the term $V°_R$. Retardation volume was preferred to net retention volume, and a plea was made that the expression for calculating j be published in a form which could not be misinterpreted. Mr. Primavesi commented on the modes of presentation of specific retentions, and expressed the view that it was more convenient to have retention data measured at the column temperature.

Replying to these and other comments which had been received, Dr. Ambrose stated that, although the relation of partition coefficient to retention data is included in the recommendations, it is not regarded as a retention parameter but merely as an example of one of a number of physical constants which can be determined by gas chromatography. The Task Group had taken as a fundamental experimental quantity the retention volume V_R, which is a volume of gas; the fact that the actual measurement was made in time or distance was irrelevant. The term $V°_R$ was retained with its original definition on historical grounds but with the qualification that "this

quantity is of limited use because it is influenced by the volumes of sample injector and detector as well as the interstitial volume of the column", because Martin and James made no mention of the significance of measurement from the air peak and, in fact, defined the ratio V_{R_1}/V_{R_2} as relative retention. Some confusion had arisen over the use of the term V_g; it had been used to describe specific retention per gram at the column temperature and at 0° C. There was very little to choose between the two interpretations, and the latter was chosen for recommendation because flow-meters are usually calibrated at 0° C and the plot of V_g at 0° C. against $1/T$ is linear. Authors are advised to indicate the definition of V_g used when reporting results.

Speaking as a teacher requiring a logically correct approach to theory, Prof. P. Chovin (Laboratoire Municipal, Paris, and chairman of Groupement pour l'Avancement des Méthodes Spectrographiques) preferred to develop it from an ideal column without external dead volume in which retention volume is a 'true' value. This concept does not affect adjusted, absolute and specific values. However, in the case of column performance where retention is measured from the point of injection, comparison of the 'true' and 'real' values gives valuable information on the loss of performance resulting from parts of the apparatus external to the column. The difficulties associated with the measurement of effective injector and detector dead volumes limit the practical interest in 'true' retention parameters. Prof. Chovin also discussed a new parameter, net retention volume per mole of liquid phase, and its application to the determination of activity coefficients. If the activity coefficient of a solvent–solute system at a given temperature was known, the value for the same solute with a different solvent could be determined very simply, and for this purpose a dual column assembly in one vapour jacket had been used.

In a paper by Mr. R. L. Martin (Standard Oil Co., of Indiana), read by Dr. A. Goldup, work was described which was interpreted as indicating adsorption effects at the liquid–gas interface. Such a phenomenon seriously affects the derivation of partition coefficients and other derived thermodynamic functions unless corrected for. In some circumstances the correction could amount to more than 80 per cent of the measured retention volume. With packed columns it had been found that the order of elution of hydrocarbon solutes varied with the amount of liquid phase, and the plot of retention volume per gram of column-packing versus liquid-phase percentage did not extrapolate to zero retention at zero liquid phase. With non-polar liquid phases the deviations were small and were attributable to adsorption on the support. With polar liquid phases the deviations were considerably larger and varied with the liquid phase. Using values for liquid surface area obtained by subjecting the coated support to the gas chromatographic continuous-flow method for surface area of solids, retention volumes were accounted for as the sum of a contribution by solution in the liquid (partition coefficient × volume of liquid) and a contribution by adsorption on the surface of the liquid (adsorption coefficient × surface area of liquid). The contribution by solution increased linearly with increase of liquid phase, but the contribution by adsorption decreased due to the decrease in liquid surface area as the percentage of liquid phase increased. Calculated 'adsorbabilities' for saturated hydrocarbons on polar liquid phases bore an inverse relation to the surface tension of the hydrocarbons. It was also noted that column performance was considerably greater with liquids on which adsorption occurred.

Mr. W. T. Swanton (British Petroleum Co.) questioned the validity of some of the arguments, and indicated that effects due to the solid support, uncoated support in particular, should be considered carefully. The relative values obtained for some of the 'adsorbabilities' were also queried; static experiments and application of the Gibbs adsorption equation might clarify the position. Further discussion on this interesting paper was limited by the absence of the author.

Dr. E. Kovats and Dr. J. F. Smith each presented methods for reporting data which go a long way towards solving the difficulties of analysts, who so often find that their extensive collection of relative values is of limited application because it lacks a common denominator relating the different standards which have been used to cover liquid phases of diverse type and a variety of temperatures.

In the Retention Index Scheme proposed by Dr. Kovats (Laboratory for Organic Chemistry, Zurich) the retention of a solute is given as a value obtained by logarithmic interpolation between the values for two even-numbered *n*-alkanes which, for convenience, are assigned values equivalent to one hundred times their carbon number. The good repeatability and reproducibility of the method were illustrated with the aid of values calculated from retention data published by other workers; however, as with other forms of retention data, possible effects of solid support must be considered and care taken in standardizing on a reproducible support. Except for small molecules such as methanol and nitroethane, where the functional group dominates, the variation of retention index with column temperature is small and linear—about four units per ten degrees centigrade. From the results of a large number of determinations, the difference between the retention indexes of two close-boiling isomers is deduced as five times the difference between their boiling points (°C.). Retention indexes increase by one hundred units on both polar and non-polar phases for the higher members of any homologous series with the insertion of a $-CH_2$ group. Differences in values obtained on polar and non-polar phases can be ascribed to solute type. For non-polar hydrocarbons the difference is zero. Dr. Kovats presented evidence that bonding types and functional groups in a molecule can each be assigned a difference value, which for a given polar liquid phase are additive.

With Dr. Smith's theoretical nonane or R_{x_9} method, which has been used extensively and proved invaluable in the laboratories of the Natural Rubber Producers' Research Association, all values are expressed relative to the retention time for *n*-nonane, which is obtained by extrapolation or interpolation from the logarithmic retention time versus carbon number plots with *n*-alkanes. A simple relation between the R_{x_9} value and the retention index was shown to exist. Statistical examination of the results obtained for various chemical classes on squalane and dinonyl phthalate at several temperatures showed that the repeatability for the whole calibration procedure and determination of relative value were at least as good as for methods involving the use of one or more standards within the chromatogram.

C. G. Scott

CONDITIONING AND ELECTRO-PHYSIOLOGY

A PAVLOVIAN Conference on "Higher Nervous Activity" was held during October 13–15 in New York, under the auspices of the New York Academy of Sciences and the Academy of Medical Sciences of the U.S.S.R. This Conference follows, in its main lines, a number of recent international meetings such as the Moscow Colloquium on "Electroencephalography and Higher Nervous Activity", the Montevideo Symposium on "Brain Mechanisms and Learning", and the Macy Conference series on the "Central Nervous System and Behaviour". These Conferences have been promoted because of widespread belief, explicitly stated by Magoun in his contribution to the New York Conference, that "the most striking recent progress in the biology of Higher Neural Activity has unquestionably come from electrophysiological analyses of the mechanism of learned behaviour. Knowledge has especially been advanced by marriage between the electrical recording techniques of Western neurophysiology and the classical Pavlovian approaches to the study of conditioned reflexes cultivated so extensively in the U.S.S.R.". The proceedings of the entire meetings will be published in the *Annals of the New York Academy of Sciences*. Attendance at the meetings averaged about eight hundred persons on each of the three days.

How does this Conference conform to a reformulation of Parkinson's law, namely, that regardless of new material available the number of words spoken at a conference will expand to fill the *Proceedings* published a year or two later? On the whole, expectations are fulfilled. There are some semi-philosophical discussions "on the relationship between neurophysiology, psychophysiology, psychopharmacology and other disciplines", which are not likely to throw much light on the difficult task of analysing the cortical and subcortical events taking place during conditioning. We have a rather expanded account of "The Role of Slow Waves in Differential Inhibition" based on records obtained from electrodes implanted with unknown accuracy "in the visual cortex, auditory cortex, medial suprasylvian cortex, dorsal hippocampus, ventral hippocampus, mesencephalic reticular formation, centralis lateralis, centre median, medialis dorsalis, and the lateral geniculate body" of two cats in which the conditioned avoidance response to flickering light was established. The results of this "admittedly crude and exploratory pilot study" are not particularly informative; conclusions are of the nature that "our electrographic data indicate that cortical slow waves are associated with inhibition, although they do not preclude excitation"; and we also have "The First Law of Bio-Cybernetics: Unidirectional Rate Sensitivity", which attempts a mathematical expression of heart-rate and pupillary reflexes. This paper will, no doubt, appeal to mathematicians familiar with Laplace operators, but will leave most biologists doubtful about the applicability of this type of analysis to sets of data still very much in search of appropriate causal factors.

From the point of view of the Western reader, no doubt the most interesting and important papers will be the Russian ones, particularly those by P. K. Anokhin and E. A. Asratyan. These not only give a summary of work done over the years in the laboratories of these two contributors but also report work which, to the present reviewer at least, was unknown and interesting.

Anokhin, after directing attention to the fact that many years ago Pavlow had already emphasized the importance of subcortical centres in ensuring a "high energy level for the functional interactions among the cortical elements", began his talk "with a formulation of some perfectly obvious contradictions which are now arising between the basic ideas of modern instrumental neurophysiology and the physiology of higher nervous activity. . . . The main contradiction is in the understanding of the essence of the ascending non-specific activity effect of the reticular formations of the stem and thalamus on the cerebral cortex". The problem, as it appears to Anokhin, is this: "The generally accepted interpretation of this phenomenon assumes that this effect is generalized throughout the entire cortex and probably all the cortical cellular elements. *Desynchronization*, that is, transformation of the slow-wave and high-amplitude electric activity into low-amplitude and high-frequency electric activity, is usually regarded as electrophysiological expression of this generalized activation. . . It is silently assumed that this activity concerns *all the cell elements of the cortex*, hence, its designation as 'diffuse' activity".

This diffuse and non-specific activity contrasts with the very highly specific formation of conditioned reflexes, that is, the creation of "the temporary bond between the given stimulus and any inborn activity of the organism". As Anokhin puts his problem: "How can generalized and apparently diffuse activation of the cerebral cortex be combined with the finest selective interactions between the cortical elements down to and including individual synaptic contacts?" Anokhin's very lengthy address summarizes the extensive work of his school relating to this problem, which has proceeded along two main lines. In the first place he has made a comparative evaluation of the activating effect of the cerebral cortex under conditions of two biologically opposed states of the animal—defensive and alimentary; and secondly, he has worked by means of stereotaxic placement and micro-electrode techniques of evoked potential. He studied "the ways of the ascending influences on the cortical element under different pharmacological effects and at different stages of ontogenetic development". The results of all this work are interpreted by him as throwing considerable doubt on the notion of 'diffuseness' as applied to the activating effects of the subcortical structures.

Asratyan is concerned with "The Question of the Initiation and Localization of Various Types of Cortical Inhibition in the Elements of the Conditioned Reflex Arc". He opposes both the two traditional

views, that is, "that conditioned inhibition is initiated in the cortical nerve cells of the focus of the conditioned stimulus", as well as the alternative view, "that conditioned inhibition is initiated in the nerve cells of the focus of the unconditioned stimulus". (He also rejects the view of Kupalov, which combines these two hypotheses.) Asratyan's own theory amounts to saying "that conditioned inhibition is initiated primarily in the elements of the conditioned connexion itself, which we represent as a chain of internuncial neurones". Most of the work he quotes in support comes from experiments on "trans-switching"; this term is used by him to designate an experimental paradigm in which ". . . a single indifferent stimulus is given two different signal values at the same time. This is done by reinforcing the stimulus differently in two different experimental conditions or situations". These experiments are interesting, but scarcely conclusive; Asratyan does not, for example, discuss at all the difficulties which would be presented for his theory by the results of Culler's classical experiment of 1938.

It is noteworthy that, while the American and Russian participants at this Conference do occasionally take notice of each other's work, yet in the main there is no real bridge from one group of workers to the other. This may be a question of nationality and politics; but other possibilities spring to mind. Electro-physiologists in the United States, and in Great Britain too, pay just as little attention to the work, or the contribution, of Western psychologists active in the field of modern learning theory and conditioning as they do to the Russians; the encapsulation of separate disciplines is more likely to be the villain of the piece, rather than national or political prejudices.

H. J. EYSENCK

THE CHANGING INDUSTRIAL ENVIRONMENT

THE theme of the annual conference of the Institute of Personnel Management which was held at Harrogate during October 7–9 was "People and Machines".

Various developments in personnel management and industrial relations were considered by the 1,200 individuals who attended from industrial companies, local and central government departments, universities and other higher educational institutions throughout the world. The tone and conduct of the conference were again on such a high plane that it is bound to have far-reaching consequences. Responsibility for organizing a conference which, outside those of political parties and trade unions, is probably the biggest in Great Britain lies mainly with Miss H. E. Cutting, who must be congratulated for the quietly efficient way in which these conferences take place.

The opening address was given by the newly appointed Minister of Labour, the Rt. Hon. John Hare, who, after reviewing the general principles on which the Government acts in the field of industrial relations, described the measure of success which stems from the British system of free negotiation. In the twelve months from June 1959 to June 1960, for example, more than 300 important claims for increased wages or shorter hours covering practically the whole of industry were settled peacefully, while less than ten resulted in disputes which led to strikes.

Strikes can be put broadly into two categories. First, there are strikes over clear-cut economic issues affecting wages or conditions of work. These, if they take place after the procedure of negotiation has been followed and failed to produce agreement, are one of the consequences to be accepted as inevitable from time to time in a free society where those who work have the right and power to seek the conditions of employment they feel that they are entitled to.

The second category contains the large number of strikes in individual establishments over a wide variety of difficulties, not only wages, which arise between management and labour or between different groups of workers. They arise over such issues as discipline, dismissals, redundancy, working arrangements and union membership. The causes of many of them are sometimes obscure—at least to the general public. Most of them are unofficial.

This second category of strike has recently given rise to public criticism. Industry itself, both employers and trade unions, is gravely concerned about them. Mr. Hare indicated that these criticisms and fears are justified because these strikes indicate continuing weakness in the present system. The Minister recommended that the two sides of the motor-car manufacturing industry should set up a top-level study group, or informal committee, to produce constructive proposals for overcoming the problems which cause regrettable stoppages within the industry—whether these problems arise on the management or the workers' side. The Minister indicated his readiness to help such a group.

At one of the sectional meetings the issue of whether collective bargaining should be carried out nationally or locally was examined. Prof. E. H. Phelps Brown showed how, in the years of full employment since the Second World War, there has been a substantial increase in the extent to which actual terms and conditions of employment are regulated by bargaining between firms and their own workpeople. Much of our collective bargaining now has a two-tier structure: from time to time each employee gets a rise the amount of which is fixed by an industry-wide bargain, but this actual rate depends also on a bargain struck within the firm. The procedure by which these local agreements are reached vary widely, and many are informal, but, in one way or another, they involve negotiation between a firm's management and its own work-people.

Is this development to be welcomed or resisted? Negotiation firm by firm avoids the danger of industry-wide bargaining and that rises in money wages will be granted too readily, because all competitors will have to pay them and so expect to be able to cover them by a general rise in selling prices. On the other hand, there is a danger that the different rates for the same job in different firms will give rise to unrest and whip-sawing.

Mr. G. Moxon, of United Glass, Ltd., was firmly against any proposal to decentralize wage-rate bargaining. Such a proposal presents a major

change to the established and traditional system affecting all companies in some degree or other, but affecting most markedly multiple companies with factories in different parts of the country.

Moxon's objections to the proposal may be summarized as follows: there is no evidence that the decentralization of wage negotiations would result in more acceptable bargains than is the case under the present system. On the contrary, it is at least possible that disputes would increase and factory relations would become worse if wage-rate bargaining were brought to the factory floor. There is no evidence that the decentralization of negotiations would diminish such tendencies as there are to a wage–price spiral; decentralized wage-rate bargaining is likely to have the effect of transferring a good deal of responsibility for bargaining away from the senior ranks of trade union officials (for example, national officers), into the hands of less-experienced, and sometimes less-successful, officials at plant-level where shop stewards will exercise a considerable influence; factory bargaining for increases beyond minima would necessitate some unified body of unions to negotiate on a common front with company management. This would mean a unified body embracing craft and general workers' unions. Without this safeguard, management would be exposed to leap-frog tactics by the various unions with which it negotiates.

The education and training of technicians were elaborated by Mr. J. S. Newton of Pilkington Bros., who used sections of the Crowther Report to distinguish between the craftsman, technician and technologist. The former has sufficient skill to make components, the second has enough training and industrial experience to supervise the carrying out of various skills, and the technologist has sufficient training to apply highly complicated scientific and technological methods to production. The technician has been brought into existence in order to solve a two-fold problem: (*a*) craftsmen in modern times are being asked to tackle work beyond their scope; (*b*) highly trained men are being wasted on work requiring much less potential. The technician must have extensive grounding in many skills, and must be intellectually more able than the craftsman. He must supply the 'know-how', and acquire the arts of communication and management. He forms the vital link between the other two grades.

Industry must decide what its requirements are in each grade, and begin by careful selection for each grade, considering educational qualifications along with general background. This may help to decrease the failure-rate between commencing and finishing a college course.

Training given at work must be carefully planned, and watched closely if it is decentralized; trainees should not be used as cheap labour. The training officer must have a clear-cut policy to implement, and planning and reports must be centralized. If training is centralized, it must not be isolated from production. If it is decentralized it must be on a systematic basis, with set periods under different operator/trainers, who must be paid special rates so that their earnings do not suffer. Industrial training must supply the trainee with as wide a field of experience as possible, filling in gaps with short-period visits to other factories, on an exchange system. Trainee technicians must have early experience of dealing with emergencies. Training must be devised to develop and mature their personalities.

The British contribution to the development of personnel management in newly industrializing countries was discussed by two speakers with considerable experience overseas. Mr. F. J. Pedler, of the United Africa Co. Ltd., declared that the golden rule for staff relations is to treat African workers in Africa as one would treat English workers in England. "If one begins by treating an African trade union as one would treat a respectable trade union in England one cannot go very wrong." The assumption is too commonly made that trade unions in Africa are subversive, communist, corrupt and unrepresentative. Some African trade unions are fully responsible. It is true that some are dominated by communists, and others, without being communist, are identified with political parties in their own country. The influence of Israel on trade union structure has been strong in some African countries.

Employers should be bold and sympathetic in recognizing unions and helping them to develop along the right lines. The technique of a joint industrial committee, for example, has been widely used in Africa with success.

The basic fact about African labour is that it is very scarce. It has to be managed as a scarce commodity, as it already commands the price of a scarce commodity: the position in Africa is very different from India.

It is important that political urges and economic development should be brought into harmony and made to serve useful ends. In this problem, personnel management has a big part to play. Such management must handle the basic problem of labour scarcity in such a way that the cost of wages and fringe benefits do not put a brake on investment.

The training of staff at all levels is essential. One of the important things which England can pass on to Africa through good personnel management is the conception of a commercial company as a community of men united for a common purpose: and, within the larger community, the conception of each unit—whether it be a department or a training school—as a team in which there are corporate interests. The most important step in achieving such a spirit is to promote Africans to be managers and to associate them fully in running the business.

Mr. John Marsh, Industrial Welfare Society, suggested that, in helping the development of personnel management in countries overseas, the British contribution should insist that our daily practice in industry and commerce should be an example. This is particularly true if the British control or administer expatriate enterprises in foreign lands.

Personnel officers and other managers who serve abroad for a portion of their lives are especially important as ambassadors of modern Britain. The Government is making a special effort to ensure that teachers going to the Commonwealth should have safeguards in their future careers, and Civil servants serving in other lands are now more satisfactorily protected. Service in industry and commerce overseas is still a handicap instead of a credit to a man's career. By sharing our knowledge and experience with indigenous managers and specialists sent to the United Kingdom for training and development, Britain makes a considerable contribution to the development of good industrial relations overseas.

The closing address was given by Sir Ben Lockspeiser, of Tube Investments, Ltd., who described the evolution of machines manufactured by man to create

the environment in which he now lives. But, although man is good at designing machines, he is not so good at understanding human behaviour, and the introduction of electronic machines could have lamentable social consequences if the personal problems involved are neglected. Many people are bound to be affected personally. Considerable changes of technique cannot be brought about overnight. The period of adjustment is long enough to give those in authority the opportunity of using the means at their disposal, such as retraining schemes and the adaptation of recruitment and wastage-rates, to anticipate consequences and work out the necessary human measures to meet new circumstances. Good personnel management must accompany a developing technology.

T. H. HAWKINS

EPIDEMIOLOGY OF BLACK RUST OF WHEAT

A SYMPOSIUM on "Epidemics of Black (Stem) Rust of Wheat" was held in the afternoon of October 7 under the auspices of the British Mycological Society. Mr. L. Ogilvie (National Agricultural Advisory Service, Bristol) said that the alternate host of black rust, wild barberry, does not appear to be implicated in the origin of uniformly distributed and almost simultaneous epidemics in the south-west of England. It was therefore decided to find whether uredospores are transported from the Continent in the same way as they are carried northwards from Texas into the American wheat belt.

Collaborative investigations which have been proceeding in Western Europe and North Africa since 1958 show that the disease overwinters in the uredospore stage on wheat and grasses in North Africa and Southern Iberia, and spreads northwards in summer. Observations on field crops and on some thirty widely scattered 'rust nurseries' (small plots of varieties of spring wheats) were organized from Bristol. About a fortnight after uredospores were trapped in quantity, rust was found in the fields and from then on became common in most of the southern coastal areas, the Channel Islands and Isles of Scilly and, later, to a lesser degree, in the whole of the southern half of England.

Dr. I. G. Thorpe (National Agricultural Advisory Service, Bristol) stated that the oat, barley, and some grass varieties of *Puccinia graminis* are not uncommon on barberries in England, but the wheat variety has not been found in recent years. The simultaneous appearance of the disease over a large area suggests a widespread inoculum. Uredospore deposits on spore traps can usually be correlated with air trajectories from countries to the south, as is explained later. Up to the present, the spectrum of rust races recognized in England greatly resembles that of the Iberian Peninsula and France. Mr. H. A. Hyde and Mrs. K. F. Adams (National Museum of Wales, Cardiff) reported that black rust uredospores have been found from May onwards in the spore catches organized by the Asthma and Allergy Research Unit at Cardiff and the Bishop Rock Lighthouse, often before wheat is affected in England. Simultaneous catches of black rust spores have often been made at points more than 150 miles apart. The theory of spore clouds originating from the Continent is supported also by catches in spring of pine pollen, which apparently came from southern Europe.

Mr. W. H. Hogg (Meteorological Office, Bristol) described how air trajectories could be prepared from weather maps, and gave estimates of the errors involved. Uredospore catches in London during the period July 4–10, 1959, were accompanied by air trajectories from the Continent. When the air came from other quarters, spores were few or lacking. Dr. J. M. Hirst (Rothamsted) dealt with theories underlying the liberation, transport and deposition of rust uredospores. Sampling from aircraft traversing southerly airstreams over the English Channel have shown large numbers of spores at heights up to 7,000 ft.

Conclusions which may be drawn from the symposium are that a severe black rust epidemic in England depends on susceptible varieties of wheat (all varieties grown here are susceptible to the common West European races of black rust), lateness of the wheat crops, transport of spore clouds arising from epidemics to the south by one or more favourable wind trajectories in late June or early July, and warm and humid weather at the time of infection and for several weeks later.

TROPICAL ECOLOGY

ECOLOGICAL terminology and concepts applicable to, and developed under, temperate conditions sometimes have little relevance to the vegetation of the tropics, and a journal devoted especially to tropical ecology will be welcomed by many as meeting a real need, so long as it does not encourage ecologists in differing climatic zones to overlook the essential unity of their subject.

Nos. 1 and 2 of Vol. 1 of the *Bulletin of the International Society for Tropical Ecology* give little indication of the extent to which this new journal will, in fact, meet the need which undoubtedly exists. No. 1 contains a presidential address: "Why Tropical Ecology?" by J. C. Sen Gupta, as well as abstracts of 22 papers, mainly on tropical forests, given at a symposium on forest ecology held at Bombay. In No. 2 are rather longer accounts of 21 papers read at a forest ecosystem symposium which was a part of the ninth International Botanical Congress held at Montreal. There is thus an absence of research papers of the conventional type; but it is useful to have the views of experts from many countries on forest classification assembled together in a single volume in this way.

No indication is given as to whether succeeding numbers of this journal will be restricted to abstracts of papers read at symposia and conferences, or whether the journal is to restrict itself to tropical

plant ecology. Until it is possible to see what permanent form this new journal takes, it can be given only a qualified welcome, although a forum in which ecologists of the tropics can discuss their special problems and report on their work is undoubtedly needed.

The *Bulletin* is edited by Dr. G. S. Puri, general secretary of the Society, 10 Chatham Lines, Allahabad, India, assisted by an editorial board with representatives from Japan, India and Great Britain. It is not priced, but is distributed to members of the Society (annual subscription 15 rupees, or £1 2*s*. 6*d*.).

OBSERVATIONS OF FALL-OUT IN INDIA DURING THE PERIOD OF CESSATION OF NUCLEAR TESTS

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THE recent measurements of fall-out in different parts of the world have provided evidence of a shorter time of residence of fission products in the stratosphere than had been estimated earlier[1–5]. Martell[1,2] has suggested residence-time in the stratosphere of 6 months–1 year for the tests carried out in the polar regions and 3–5 years for the tests carried out in the equatorial regions. The investigations on fall-out carried out in Norway[3] have shown that the airborne activity at the ground-level starts increasing shortly after high-yield tests, reaches a peak value in about six to seven months and then decreases with a half-life of about one month. These measurements also suggest a short value of mean residence-time in the stratosphere.

The ground-level airborne fall-out activity in India[4] after October 1958 showed a trend somewhat similar to that observed in Norway. A rise in airborne activity was observed soon after the completion of high-yield tests carried out in the polar regions in October 1958. This increase continued, and a maximum was reached at all the stations after about four months, that is, during February–March 1959. This activity decreased with a half-life of about 40 days, suggesting residence-time in the atmosphere of about 60 days.

We have also studied the ratio of zirconium-95 and cæsium-137 activities in samples of rain-water from Srinagar and Bombay during the period December 1958–September 1959. The change in this ratio with time seems to provide some information regarding the relative proportions of fall-out debris from the old tests and the October 1958 polar tests. The mean residence-time in the atmosphere has also been estimated indirectly from this ratio and is found to be about 60 days.

The obvious consequence of short residence-time in the stratosphere is an increase in the external gamma-radiation dose for several months after high-yield tests. The radiation dose from the gamma-emitting isotopes (zirconium-95 + niobium-95), (cerium-144 + praseodymium-144), ruthenium-106 and cæsium-137 after the October 1958 test series has been estimated from the observed levels of activity.

Airborne Radioactivity

Fig. 1 gives the concentrations of radioactive fall-out fission products in the air at ground-level at different stations in India for the period October 1958–June 1959. The airborne radioactivity shows a steady increase after October 1958, reaching a peak value in about four months. The peak in activity is observed at all the stations, except Ootacamund, during the months of February and March, after which the activity decreases with a half-life of about one month.

The increase in activity to the peak value during the period of about four months after the October 1958 test series may be explained as due to the storage of the debris in the troposphere determined by the mean residence-time in the troposphere, which is of the order of 20–30 days. The decrease in airborne activity at ground-level will be governed by the trend of decrease in the troposphere, which in turn would depend on the residence-time in the stratosphere.

The levels of airborne radioactivity averaged for all the stations for each month and corrected for radioactive decay to October 15, 1958, have also been plotted in Fig. 1, and a smooth graph has been drawn through these points to give a picture of the general trend of variations of airborne activity at ground-level. This graph shows that, after the peak is reached, the activity decreases with a half-life of 40 days, as determined from the slope, corresponding to a mean residence-time in the atmosphere of about 60 days.

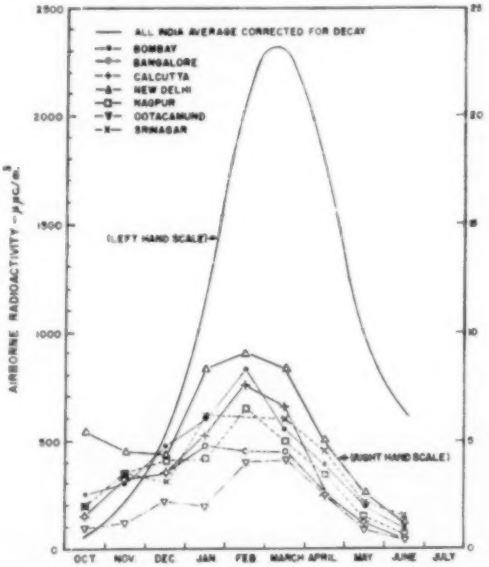

Fig. 1. Average monthly levels of airborne radioactivity at different stations in India during October 1958–June 1959. The smooth curve shows the level of airborne radioactivity averaged for all the stations for each month and corrected for radioactive decay to October 15, 1958

Table 1. Infinity External Gamma-radiation Dosage from the Monthly Deposition Zr-95 Nb-95, Ce-144 Pr-144, Ru-106 and Cs-137 at Srinagar during October 1958–June 1959

Month	Zirconium-95 + niobium-95 (m.rems)	Cæsium-144 + praseodymium-144 (m.rems)	Ruthenium-106 (m.rems)	Cæsium-137 (m.rems)	Total (m.rems)
October	0·14	0·039	0·048	0·76	0·99
November	0·22	0·048	0·026	0·81	2·11
December	1·69	0·180	0·306	3·08	5·25
January	1·85	0·178	0·318	3·04	5·39
February	1·03	0·169	0·542	5·62	7·36
March	2·79	0·256	0·607	6·53	10·18
April	1·22	0·169	0·860	5·25	7·50
May	1·55	0·240	0·739	7·40	9·93
June	0·14	0·048	0·140	1·63	1·96

Zirconium-95/Cæsium-137 Ratio in Rain-water

Monthly collections of rain-water from Srinagar for the period October 1958–June 1959 and individual rain samples collected at Bombay during June 1959–September 1959 were analysed for zirconium-95 and cæsium-137 activity using a gamma-ray scintillation spectrometer. The scintillation spectrometer consisted of a 10-channel pulse-height analyser, and a well-type sodium iodide scintillation detector. Each sample was counted several times over a period of 5–6 months, and the 0·75-MeV. gamma-ray peak due to zirconium-95 verified for its 65 days half-life. The activity of each sample was corrected for decay to the middle of the collection period.

Fig. 2 shows the zirconium-95/cæsium-137 ratio for the period October 1958–September 1959 for both Srinagar and Bombay samples. It will be seen that the ratio rises at Srinagar in December 1958. This indicates the increase of fresh nuclear debris in the troposphere, presumably from the October 1958 tests. During December 1958–May 1959 the ratio decreases, and the points lie close to the decay curve of zirconium-95 (half-life 65 days) shown by line *AA*. The observed ratios for June 1959 and subsequent samples show an increasing departure from line *AA*. The departure may be explained as follows.

As will be seen from Fig. 1, the airborne activity which had shown an increase following the October 1958 tests came down to a fairly low level in June 1959. After June 1959 one would therefore expect an increasing proportion of fission products from the earlier equatorial tests, which probably have a larger residence-period in the stratosphere. Thus the ratio zirconium-95/cæsium-137 in the precipitation samples after June would be more dependent on the relative abundance of cæsium-137 from equatorial and polar tests. If we assume that the fall-out from the polar tests in 1958 is superimposed on a constant background of cæsium-137 from earlier tests, and that all the zirconium 95 activity in the atmosphere during June–September 1959 is from October 1958 tests, the departure of zirconium-95/cæsium-137 ratio from the calculated value from June onwards should be due to the rapid depletion of the debris of polar tests in the atmosphere. The residence-time in the atmosphere for the debris from polar tests is estimated from a least-square fit to the points between June and September as shown by line *BB*. The slope of this line gives $(\lambda_R + \lambda_T)$, where λ_R is the radioactive decay constant for zirconium-95 and $\lambda_T = 1/\tau$, where τ is the mean residence-time in the atmosphere for debris from polar tests. The value of τ is calculated from line *BB* to be about 60 days.

Estimates of the External Gamma-radiation Dose

The levels of deposition of (zirconium-95 + niobium-95), (cerium-144 + praseodymium), ruthenium-

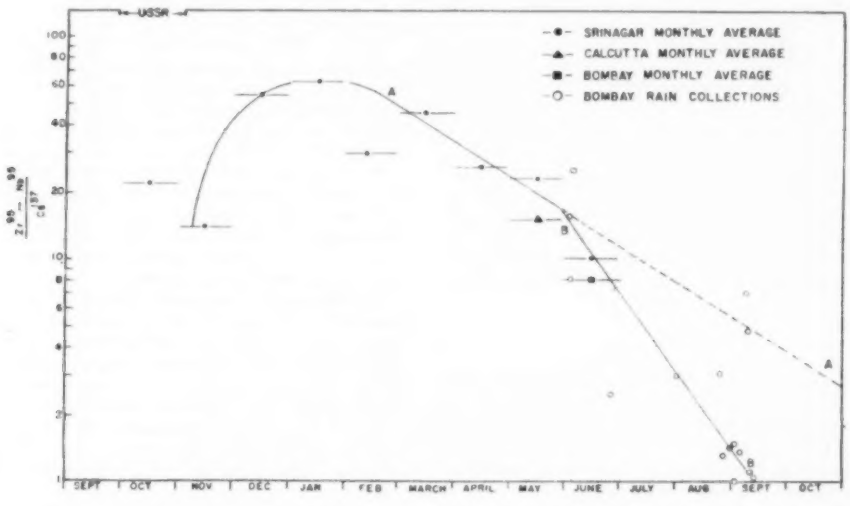

Fig. 2. (Zirconium-95 + niobium-95)/cæsium-137 ratio in rain-water for the period October 1958–September 1959. Line *AA* corresponds to the radioactive decay of zirconium-95, and line *BB* is a least-square fit to the experimental points during June–September 1959

106 and cæsium-137 were measured in the monthly collections of rain-water at Srinagar for the period October 1958–September 1959. The infinity gamma-dose from these isotopes has been estimated for the different months and the results are shown in Table 1. The maximum dose is about 10 m.rems observed in the month of March 1959. The total dose from these isotopes during October 1958–June 1959 is about 50 m.rems. The actual dose will be higher than this, because the contribution from the shorter-lived isotopes has not been considered.

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MEMORY EFFECT IN THE THERMAL INITIATION OF EXPLOSIVES

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THE 'memory effect' is a quite well-known phenomenon in the thermal sensitization of explosives. It manifests itself through the apparent equality between the time of ignition delay (induction period) of an unsensitized sample and the sum of the durations resulting from several thermal treatments. Thus, Ubbelohde[1] found that the total induction periods of lead azide and mercury fulminate heated at a given temperature T_0 are practically the same whether measured in one or more stages. Multi-stage heating involves heating a sample at T_0 for a time t_1 followed by chilling and repeating this cycle one or more times until an explosion is finally observed. Algebraically, this can be stated by the equation:

$$\tau_0 = t_1 + t_2 + \ldots + \tau \qquad (1)$$

where τ_0 is the one-stage induction period, t_1, t_2 . . . are the durations of the first, second, etc., heating stages, and τ is the time to explosion associated with the last heating stage. It is experimentally observed that τ_0 is a lower limit for the sum of terms on the right side of equation (1).

Jones and Jackson[2] observed the memory effect in both primary and secondary explosives. These authors presumed this effect to be related to the kinetics of the decomposition reaction, since a shortening of the induction period occurred only where autocatalysis by condensed decomposition products had been definitely established. In this article an attempt is made to explain the effect in terms of equation (1) and a particular autocatalytic reaction equation. Then, the memory effect is seen to depend primarily on the concentration of catalyst formed during the thermal treatment, since the rate of the decomposition reaction naturally increases with increasing initial concentration of catalyst.

Measurements of the induction period as a function of temperature generally follow the Semenov equation:

$$\ln \tau = B + \frac{E}{RT} \qquad (2)$$

which permits one to calculate values for an apparent activation energy E. Theoretical justifications of the validity of equation (2) have been supplied by several authors. For example, from the fundamental thermal theory of explosion by Franck-Kamenetski[3] (which was extended to solids by Rideal and Robertson[4]), Cook[5] derived a relation of the Semenov-type which takes into account both the heat conduction and the geometry of the sample. On the other hand, Eyring and co-workers[6] gave an expression for the induction period by assuming a first-order reaction and neglecting losses of heat by conduction. Then again, Semenov[7] treated self-ignition of gases on the basis of an autocatalytic reaction equation and the influence of heat conduction. Similarly, Andreev[8] showed that a Semenov-type relation for the induction period is obtained when an autocatalytic reaction equation is used as will be discussed later.

The basic problem in any theoretical explanation of the induction period derives from the difficulty of finding a kinetic law which is valid for the reaction under consideration. In the chain theory[9] possible mechanisms for reactions in solids have been described to a large extent. However, in spite of extensive agreement with experiments, the general validity of this theory has not yet been established.

Accordingly, we shall assume the simple autocatalytic reaction:

$$B \xrightarrow{A} A + C \qquad (3)$$

which is governed by the kinetic equation:

$$\frac{dx}{dt} = K_0(a + x)(b - x) \qquad (4)$$

Here, x is the concentration of the reaction product A with its initial concentration a, b is the initial concentration of the substance B, and K_0 is the temperature-dependent reaction-rate constant. Equation (4) enables one to derive the relationship between the amount of catalyst x produced after the time t.

It is known that equation (4) is primarily valid for certain reactions in the gaseous phase or in solutions. However, a number of experimental investigations showed that the simple autocatalytic relation is a sound approximation also in cases concerning condensed systems.

Hinshelwood[10] reported that the decomposition behaviour of molten tetryl satisfies equation (4). Prout and Tompkins[11] described the decomposition of potassium permanganate by an expression similar to the solution of the above autocatalytic law (4) derived from the expanded chain theory. The same relation fitted the decomposition curves of some organic compounds as found by Vaughan and Phillips[12]. In the theory of branching and terminated chains the following equation is derived[13]:

$$\frac{dx}{dt} = K.x.(x_f - x) \qquad (5)$$

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which neglects chain interference at $t = 0$, and differs from the autocatalytic law (4) only by the omission of the initial concentration a. This formal identity emphasizes a similarity of the picture of the Brownian movement and collisions in gases to the branching of chains in solids.

It is, however, not necessary that the kinetic law be fulfilled over the total decomposition-range. An agreement is demanded only up to the accelerating region, where slow decomposition changes to explosion. In the beginning of the reaction, the formation of catalyst nuclei takes place and secures a proportionality to the concentration. At a later stage, these nuclei may grow during the reaction, so that a certain amount of catalyst is screened out from further participation in the catalysis. As the reaction proceeds further, a transition to an interface catalysis will occur. When the interface process becomes dominant compared with the 'linear' chain catalysis the diminution of active catalyst may be described approximately by means of exponents:

$$\frac{dx}{dt} = K_0(a + x)^n.(b - x)^m \qquad (6)$$

An equation of this kind has been used already for complicated gas reactions by Semenov[14].

The simple type of reaction equation (4) will, however, be used for mathematical treatment in this work. That means that a duration of the reaction is considered in which the growth of nuclei is negligible compared to the formation of new nuclei. This is justified very well by the chain theory itself, which claims that the reaction in a solid goes on along certain preferred paths. On the other hand, however, this supposition does not affect the autocatalytic view of the reaction. It seems reasonable that decomposition products may catalyse much more easily those neighbours in the lattice which are already in a higher energy stage. (Edge sites are preferred to surface, etc.) An autocatalytic process demands that an initial concentration of catalyst be present to start the reaction. Mathematically, this is reflected in the integrability of equation (4) from $x = 0$, when $a > 0$ is taken. The concentration a may be represented by lattice defects, etc., and will in general depend on the history of the sample. This explanation does not seem sufficient, however, when a assumes values too large relative to the concentration b as shown later. In these cases, one may follow the suggestion of Andreev[15] by superposing a first-order reaction which is responsible for starting the decomposition:

$$\frac{dx}{dt} = k_1.(b - x) + k_2.x.(b - x) \qquad (7)$$

It can easily be seen that equation (7) is identical to equation (4), when a is set equal to k_1/k_2.

In all the following calculations, heat conduction losses will be neglected. First, the limiting case is that in which the temperature is considered to be constant. Then, the existence of a true memory effect according to equation (1) can be shown easily. The isothermal solution (K_0 = constant) of equation (4) permits determination of the time t after which any desired amount x of catalyst has been formed:

$$t = \frac{1}{(a + b)K_0} \ln\frac{b(a + x)}{a(b - x)} \qquad (8)$$

The induction period is assumed to be the time at which the maximum reaction velocity is reached, and is determined for the untreated sample as:

$$\tau_0 = \frac{1}{(a + b)K_0} \ln\frac{b}{a} \qquad (9)$$

and for the preheated sample containing an amount of catalyst $(a + x)$ as:

$$\tau = \frac{1}{(a + b)K_0} \ln\frac{b - x}{a + x} \qquad (10)$$

Addition of equations (8) and (9) and comparison with equation (10) proves the existence of equation (1).

The experimental results show, however, that a true memory effect is never exactly achieved and that only the following inequality:

$$\frac{\tau}{\tau_0} > 1 - t \qquad (11)$$

written in relative terms agrees with the observations. Therefore, self-heating will be introduced to improve the description of the effect. The significance of self-heating is evident not only in the thermal theory of initiation of explosions by Franck-Kamenetski[16] (which is concerned with temperature increase in a heated sample), but also by experimental results of Vaughan and Phillips[17] in the case of mercury fulminate.

For practical reasons, the kinetic equation (4) is rewritten in terms of concentrations normalized with respect to the initial concentration b:

$$\frac{dx}{dt} = ke^{-E/RT}.(\alpha_0 + x)(1 - x) \qquad (12)$$

where x is now the relative amount of the reacted material; k is a proportionality factor which includes the frequency factor; E and R represent, respectively, the activation energy and the gas constant, and α_0 is the (formal) initial concentration of the catalyst. If α_0 is interpreted as the ratio of the reaction-rate constants according to Andreev[15], α_0 will be dependent on temperature, though of a lower order than k alone. This fact may permit one to consider α_0 approximately constant compared to k.

Again, loss of heat by conduction will be neglected, which is a reasonable assumption when the self-heating is small during the main part of the induction period, as is shown later. The heat of reaction evolved by an exothermic reaction will then be used solely to raise the temperature of the explosive sample. On this basis, the amount reacted x is given by:

$$x = \frac{C_v(T - T_0)}{\Delta H} \qquad (13)$$

where T_0 is the bath or hot-plate temperature, and C_v is a mean specific heat. By introducing a hypothetical temperature T_∞ which is the maximum temperature attainable in an adiabatic reaction, equation (13) can be written:

$$x = \frac{T - T_0}{T_\infty - T_0} \qquad (14)$$

From equations (12) and (14), it follows that:

$$\frac{dT}{dt} = \frac{k.e^{-E/RT}}{T_\infty - T_0}.(T - T_1)(T_\infty - T) \qquad (15)$$

where:

$$T_1 = T_0 - \alpha_0(T_\infty - T_0)$$

Integrating equation (15), one obtains, in terms of the logarithmic integral:

$$t = \frac{1}{(1+\alpha_0)k}\left\{(e^{y_1}\int_{{}_1p_0}^{\infty}\frac{e^{-p}}{p}dp + e^{y_\infty}\int_{-\infty}^{q_0}\frac{e^{q}}{q}dq) - (e^{y_1}\int_{{}_1p}^{\infty}\frac{e^{-p}}{p}dp + e^{y_\infty}\int_{-\infty}^{q}\frac{e^{q}}{q}dq)\right\} \quad (16)$$

where $y = E/RT$, $y_0 = E/RT_0$, $y_1 = E/RT_1$, $y_\infty = E/RT_\infty$, ${}_1p_0 = y_1 - y_0$, $q_0 = y_0 + y_\infty$, ${}_1p = y_1 - y$, $q = y + y_\infty$.

Fig. 1 shows the temperature-time profile schematically. (The dotted line indicates the above-mentioned influence of loss of heat by conduction.) The steep rise of temperature represents a self-accelerating reaction leading to ignition, and the time required for this to occur may be defined as the induction period τ_0, characteristic of the sample under study. Such a definition implies that near τ_0 the time is practically independent of the temperature, and consequently that the last two T-dependent terms in equation (16) compensate each other. Then the induction period:

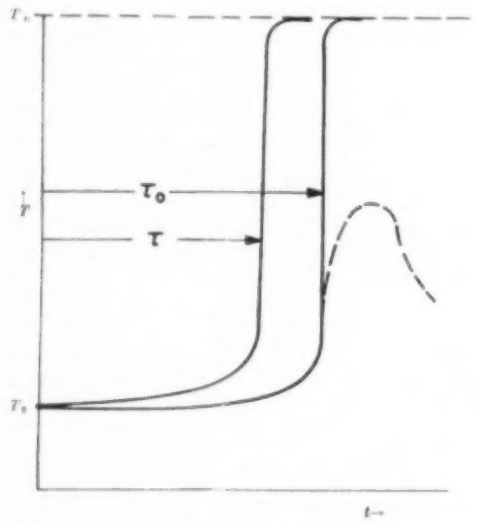

Fig. 1. Temperature–time characteristic for different initial concentration α

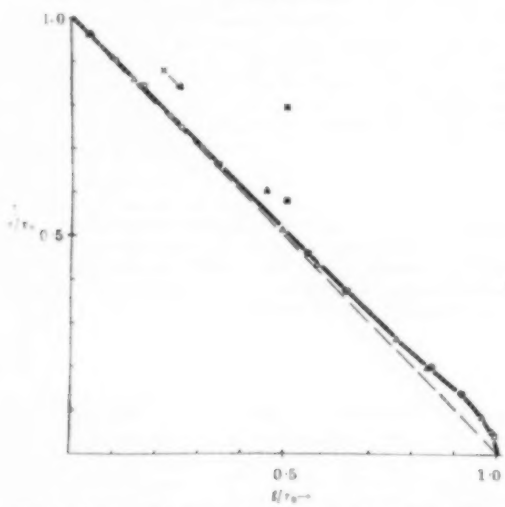

Fig. 2. Calculated pairs of values ($\cdot/\tau_0$, t/τ_0) for: lead azide, △: E = 38 kcal./mole, $\Delta H/C_v$ = 3,336° K., T_0 = 603° K.; PETN, ○: E = 37 kcal./mole, $\Delta H/C_v$ = 5,130° K., T_0 = 521° K.; tetryl, □: E = 52 kcal./mole, $\Delta H/C_v$ = 4,804° K., T_0 = 525° K.; in all three cases, $\alpha_0 = 10^{-6}$. The solid signs, ▲, ●, ■, represent experimental values

$$\tau_0 = \frac{1}{(1+\alpha_0)k}\left\{e^{y_1}\int_{{}_1p_0}^{\infty}\frac{e^{-p}}{p}dp + e^{y_\infty}\int_{-\infty}^{q_0}\frac{e^{q}}{q}dq\right\} \quad (17)$$

depends, in essence, only on the initial concentration of the catalyst and the bath temperature T_0. The memory effect is now reduced to a description of the amount of autocatalytic decomposition product formed in a given length of time.

When the autocatalytic reaction is interrupted after a heating time t by cooling the explosive sample, an amount x of the catalyst formed can be calculated by using equation (16) and the relationship between x and T shown in equation (13). When the reaction is resumed by heating to the previous temperature T_0, the initial concentration of catalyst is increased by the amount x to $\alpha_1 = \alpha_0 + x$, and the new, shorter induction time τ can be evaluated by a similar integral:

$$\tau = \frac{1}{(1+\alpha_1)k}\left\{e^{y_2}\int_{{}_2p_0}^{\infty}\frac{e^{-p}}{p}dp + e^{y_\infty}\int_{-\infty}^{q_0}\frac{e^{q}}{q}dq\right\} \quad (18)$$

where

$$y_2 = E\{R[T_0 - \alpha_1(T_\infty - T_0)]\}^{-1},\ {}_2p_0 = y_2 - y_0.$$

Knowing τ_0, τ, and t from the integrals mentioned, and assuming the constancy of k, one can check the memory effect by plotting τ/τ_0 against t/τ_0. For an exact linear memory effect, a straight line with a negative slope of unity will result. Fig. 2 shows a plot of three examples with known ΔH, E, and C_v. In all cases α_0 is chosen to be relatively small, such as

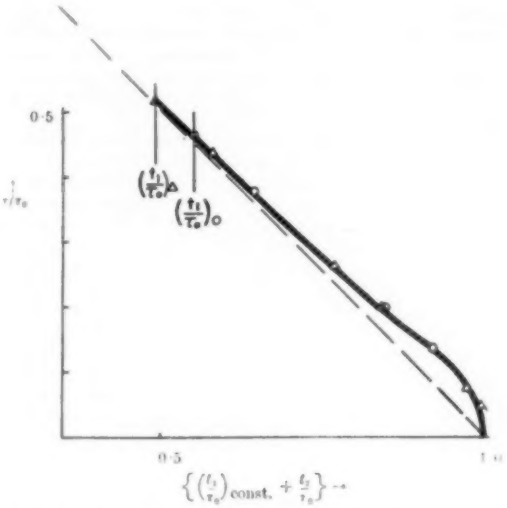

Fig. 3. Calculated pairs of values concerning the preheating times (t_1/τ_0 = const.) for lead azide (△) and PETN (○)

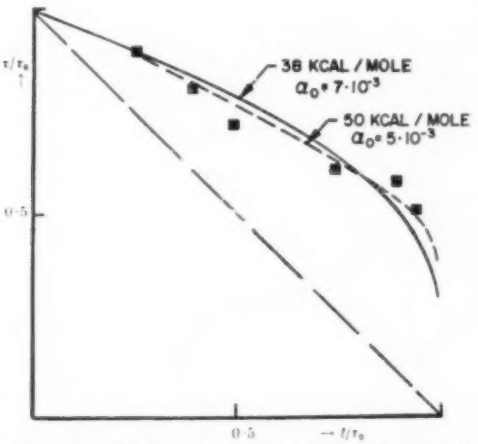

Fig. 4. Thermal sensitization of Service lead azide at 330° C. ■, Experimental values by A. S. Hawkes and C. A. Winkler, and calculated curves

10^{-8}. By this choice, the linear memory effect is still well approximated. Fig. 3 gives a demonstration of a second preheating time which causes scarcely any change of the curve (the heavy line in Fig. 3 is taken from Fig. 2).

As mentioned earlier, the experimental results for the most part do not agree with even a fairly linear relationship as also indicated by a few experimental points in Fig. 2. A theoretical curve which fits these results can be determined by changing the parameter α_0. Fig. 4 shows a comparison of memory effect data by Hawkes and Winkler[18] and two calculated curves at a constant bath temperature of 330° C. for activation energies of 38 kcal./mole and 50 kcal./mole respectively. The test material in these cases was Service lead azide, so the assumed α_0-values of 7×10^{-3} and 5×10^{-3} respectively cannot be said to be characteristic of the pure material. Nevertheless, it seems doubtful that such a relatively high α_0-value can represent lattice effects only. For lead azide, it was observed that the autocatalytic reaction is superposed by a simple, probably first-order reaction[19], in the sense used by Andreev[15]. Thus, even the degenerated, non-linear memory effect can be explained by the model demonstrated.

In summary, the mathematical treatment presented here provides a theoretical explanation of the relationship between the memory effect in an explosive and its autocatalytic decomposition as shown by the validity of equation (1) or the inequality (11), respectively.

We wish to acknowledge the encouragement of Dr. J. V. R. Kaufman.

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OCTAHEDRAL CO-ORDINATION OF NICKEL IN NICKEL(II) *BIS*ACETYLACETONE

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DISCUSSION of fourfold co-ordination of the nickel atom in paramagnetic chelate complexes of nickel(II), $Ni(x—x)_2$, where $x—x$ is a bidentate ligand such as a β-diketone or salicylaldehyde, has centred on whether such co-ordination is tetrahedral or square planar. An early suggestion[1] that magnetic data indicated the tetrahedral arrangement was rejected by Calvin and Melchior[2] as inconclusive. More recently, Maki[3] has claimed that no *a priori* correlation between the magnetic moment and structure of these complexes is possible since a molecule having, say, a square planar configuration may be either diamagnetic or paramagnetic depending critically on the strength and symmetry of the ligand field. Maki[4] indeed suggests, on the basis of the ultraviolet absorption spectrum in benzene, that nickel(II) *bis*acetylacetone, often quoted as an example of a tetrahedral complex, has a planar structure. Tetrahedral co-ordination of nickel(II) has been demonstrated for *bis*triphenylmethylarsonium nickel tetrachloride[5].

An early X-ray diffraction analysis[6] of nickel(II) *bis*acetylacetone produced the unexpected result that the molecules are trimeric; a complete solution of the structure was not possible at that time, although it was clear that the nickel atoms in the trimer might well be octahedrally co-ordinated. We now report that the complete analysis of the structure, by Fourier and least-squares methods, confirms this suggestion. The usual discrepancy factor for this kind of analysis:

$$R = \frac{\sum_{hkl} \left| |F_{obs.}| - |F_{calc}| \right|}{\sum_{hkl} |F_{obs.}|}$$

is 0·14 at the present stage of refinement and corresponds to average estimated standard deviations of 0·015 Å. and 0·05 Å. for the nickel–nickel and nickel–oxygen bond-lengths.

A perspective diagram showing the arrangement of the ligands around the nickel atoms is shown in Fig. 1; bond-lengths and bond-angles are given in Fig. 2.

A distorted octahedral co-ordination of each nickel atom results from the bridging of each pair of nickel atoms by three oxygen atoms. The Ni(1) – Ni(2) and Ni(2) – Ni(3) separations are 2·887 Å. and 2·896 Å. respectively (equal, within experimental error). The bond-angle Ni(1) – Ni(2) – Ni(3) is 179·2° ± 0·7°; the arrangement of the nickel atoms is thus linear.

The molecule as a whole is pseudo-centrosymmetric, the root-mean-square deviation of the lengths of chemically equivalent Ni–O bonds being 0·04 Å. and of equivalent O–Ni–O and Ni–O–Ni bond-angles 3°. Since the environment of the molecule in the crystal is not centrosymmetric, there is little evidence that intermolecular forces play any substantial part in establishing the molecular configuration in the crystal. The Ni–O bond-length appears to depend on whether the oxygen is bonded to only one nickel atom ($\bar{l}_{Ni-O}$ = 2·00 Å.) or shared between two nickel atoms ($\bar{l}_{Ni-O}$ = 2·12 Å.) (see Fig. 2 for spread of observed bond-lengths).

The trimeric nature of the molecule is understandable in so far as a trimer is the smallest polymeric unit in which octahedral co-ordination of all the nickel atoms can be accomplished, provided there is only intramolecular sharing of oxygen atoms. It seems possible that trimerization occurs with other complexes of this type if the chelate groups are not too bulky for steric hindrance to prevent the association. A recent investigation[7] of single crystals of nickel(II) *bis*salicylaldehyde shows that the monoclinic unit cell contains twelve formula units. Zinc(II) *bis*acetylacetone crystallizes in a similar way with a = 19·2 Å., b = 8·4 Å., c = 24·4 Å., β = 113°, and with twelve formula units in the unit cell ($\rho_{obs.}$ = 1·40 gm. cm.$^{-3}$, $\rho_{calc.}$ = 1·45 gm. cm.$^{-3}$). This implies that, as with nickel(II) *bis*acetylacetone, these structures contain trimeric units.

The present confirmation of octahedral co-ordination of the complex in the crystal makes it desirable to re-examine deductions regarding the structure of nickel(II) *bis*acetylacetone in the vapour phase and in solution. Shibata *et al.*[8,9] concluded from electron diffraction studies that the molecule is planar in the vapour phase; the analysis is inconclusive, since the possibility of octahedral co-ordination was not considered. The observed radial distribution curve does not agree well with that calculated on the basis of a planar model, and a rough calculation shows that an octahedral configuration is in reasonable agreement with the data. Isomorphism of nickel(II) *bis*acetylacetone and zinc(II) *bis*acetylacetone was also claimed[10], whereas our single-crystal X-ray studies demonstrate orthorhombic and monoclinic symmetries respectively; the identification of the present crystal structure with a yellow high-temperature modification[8] cannot be valid.

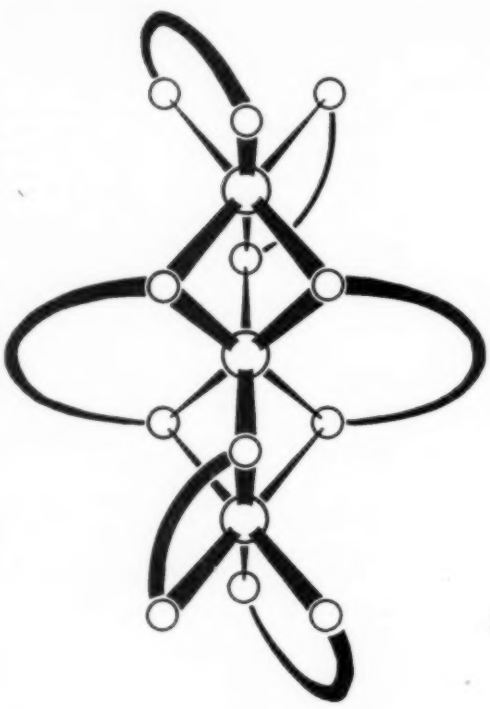

Fig. 1

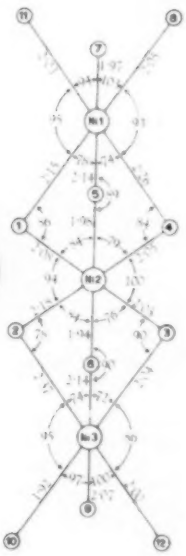

Fig. 2

Maki favours a planar structure of the complex in solution[6]; Jørgensen[11] suggests that octahedral co-ordination results from two solvent molecules (benzene) interacting in the *trans* positions. Early molecular weight determinations in benzene made by one of us indicated molecular association; more accurate measurements (F. A. Cotton, private communication) appear consistent with a monomer–trimer equilibrium. We believe that trimerization will occur as a means of achieving octahedral co-ordination, which could also be accomplished through solvent interaction with the monomer or dimer.

The calculations for this work were carried out on the University of London *Mercury* computer. We wish to thank Mr. O. S. Mills and Dr. J. S. Rollett for making their computer programmes available to us.

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SEPARATION OF UNIVALENT FRAGMENTS OF RABBIT ANTIBODY BY REDUCTION OF A SINGLE, LABILE DISULPHIDE BOND

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PORTER[1,2] has shown that hydrolysis of the rabbit antibody molecule with papain yields three fragments, two of which possess combining sites; the third is inactive but crystallizable. He reported that the molecular weight of the inactive fragment is about 80,000, while that of each active segment is 50,000–55,000. Evidence indicating that the two active fragments are univalent is their capacity to block precipitation in the homologous system; the observation of two chromatographically separable active fragments derived from the originally bivalent molecule[1,2]; and the direct determination of valence by measurement of maximum hapten-binding capacity[3].

It has been found by Nisonoff *et al.*[4,5] that successive treatments of the antibody with pepsin at *p*H 4·8, and one of several disulphide-splitting reagents at *p*H 8, where pepsin is inactive, similarly yield univalent fragments. These split-products exhibit a sedimentation pattern and coefficient (3·5 *S*) almost identical with those of a papain digest[5], and are separated into two active and one inactive fractions on carboxymethylcellulose, under conditions identical with those used by Porter for a papain digest[1]. Proteolysis with pepsin alone causes a reduction in sedimentation coefficient from about 6·5 to 5 *S*, but the product is still bivalent, as indicated by the retention of capacity to precipitate specifically. Subsequent treatment with a reducing agent or cyanide yields fragments with $s \simeq 3{\cdot}5$. Strong evidence indicating that these fragments are univalent is discussed in ref. 5. It was therefore concluded[5] that the transformation from bivalent to univalent antibody was accomplished by the splitting of one or more disulphide bonds.

Since papain, being a sulphydryl enzyme, has always been used in conjunction with a reagent capable of splitting disulphide bonds, it appeared that a similar mechanism may exist in the digestion of rabbit antibody by that enzyme; that is, removal of an inactive fragment by proteolysis, followed by splitting of the bivalent residue through reduction of one or more S—S bonds.

Recently it has been found[6] that the molecular weight of the 5 *S* precipitating fragment formed by the action of pepsin alone is 106,000, while the average molecular weight of the univalent split-products formed by the further action of a disulphide-splitting reagent (2-mercaptoethylamine) is 56,000.

In the present report data are presented indicating that this transformation can be accomplished by reduction of a single, critical disulphide bond. The results further indicate that this bond is exceptionally labile.

Three gm. of a γ-globulin fraction[7] of rabbit anti-ovalbumin was treated with 2 per cent of its own weight of pepsin at *p*H 4·5 in sodium acetate–chloride buffer of ionic strength 0·14. After incubation for 18 hr. at 37°, the mixture was adjusted to *p*H 8 and dialysed against 4 litres of cold saline–borate buffer, *p*H 8, ionic strength 0·16. The major component was isolated by precipitation with sodium sulphate[6]. On examination in the ultracentrifuge a single peak was observed with $s_{20,w} = 5{\cdot}1$. The yield of protein was 1·6 gm. or 53 per cent of the weight of γ-globulin initially present. In the procedure the final dialysis was carried out against 0·06 *M* sodium acetate adjusted to *p*H 7 with acetic acid.

Two-ml. aliquots of this preparation, containing 34 mgm. protein per ml., were adjusted to *p*H 5·0 with 2 *M* acetic acid and treated with varying amounts of 2-mercaptoethylamine hydrochloride (MEA) at this *p*H. Each reaction was allowed to proceed for 1 hr. at 37°. At the end of this period 1 ml. of 10 per cent trichloracetic acid was added to each of two 0·5-ml. aliquots taken from a reaction mixture. After standing for approximately ½ hr. each mixture was centrifuged and the precipitate was washed with two 1–2 ml. portions of 5 per cent trichloracetic acid. (It was found that MEA is soluble in 5–10 per cent trichloracetic acid.) The precipitate was then suspended uniformly in 1·2 ml. of saline–borate buffer, *p*H 8, ionic strength 0·16. A 0·1-ml. aliquot was removed for analysis of the protein concentration, and 1 ml. of suspension was dissolved in 30 ml. of the buffer used in the titration of sulphydryl groups[8]. The protein dissolved readily in each case and titrations were carried out immediately. 81–87 per cent of the protein was precipitated by trichloracetic acid in each experiment. More protein was precipitated from the supernatants during the next hour or two, but titrations were carried out early to minimize the possibility of re-oxidation of SH groups. Calculations of the number of SH groups per molecule were based on amounts of protein actually precipitated. As indicated, the procedure yielded duplicate values for the SH content of each sample.

Titration of sulphydryl groups was carried out amperometrically according to the method of Benesch, Lardy and Benesch[8] using 4×10^{-3} *M* silver nitrate. To increase the availability of SH groups a detergent, 0·5 per cent 'Duponol *C*', was added to the titration mixture[9]. In several preliminary experiments it was found that doubling the detergent concentration caused no further increase in the number of titratable SH groups.

A control was run by precipitating the protein with trichloracetic acid without prior treatment with 2-mercaptoethylamine. This was done in triplicate and gave a mean value of 0·75 mole of SH groups per mole of protein (molecular weight

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106,000), with a mean deviation of 0·09 mole of SH.

For the purpose of testing the effect of reduction on the sedimentation characteristics, aliquots of each mixture, after the reaction with MEA, were quickly cooled to room temperature and treated immediately with enough 1 *M* iodoacetamide to yield a final concentration of 0·04 *M*. In each case this represented an excess in molar concentration over that of the MEA present. The solution was adjusted to *p*H 7·0 and diluted to a protein concentration of 10 mgm./ml. with 0·1 *M* sodium acetate containing sufficient acetic acid to lower its *p*H to 7·0. Samples were then examined in a Spinco model *E* ultracentrifuge at a speed of 59,780 r.p.m. Runs were started within an hour after completion of the reaction with 2-mercaptoethylamine, except in the case noted below, where the effect of standing after treatment with iodoacetamide was tested.

The effect on the sedimentation pattern of a 1-hr. treatment with increasing amounts of MEA is shown in Fig. 1. The s_{20w} values are indicated on the diagrams. With 0·014 *M* or 0·03 *M* MEA the breakdown to $s_{20w} \simeq 3{\cdot}5$ appeared to be complete. With 0·006 *M* MEA 83 per cent of the protein was broken down, while the transformation reached 66 per cent of completion with 0·004 *M* MEA. The latter run was repeated in the ultracentrifuge after the mixture had been allowed to stand overnight at room temperature. There was no significant change in the pattern (fourth photograph, Fig. 1).

The correlation of these results with the number of new sulphydryl groups formed per molecule is indicated by the graph in Fig. 2. Complete breakdown of the 5 *S* protein was associated with the formation of between 1·7 and 2·9 moles of SH groups per mole of protein of molecular weight 106,000, which corresponds to the splitting of more than 0·85 and less than 1·45 disulphide bonds per molecule.

It is of interest to compare the fraction of 5 *S* protein broken down with the fraction of a disulphide bond per molecule split, for the experiments in which the breakdown was incomplete. The assumption is made that two new SH groups correspond to the reduction of one disulphide bond. The respective values are 0·66 versus 0·61 (0·004 *M* MEA), and 0·83 versus 0·85 (0·006 *M* MEA). The results indicate that the conversion from a sedimentation coefficient of about 5 *S* to 3·5 *S* is associated with the reduction of a single disulphide bond, and that this bond is exceptionally labile. (If the assumption is made that the 5 *S* protein consists of Porter's fractions I and II, his amino-acid analyses[2] would indicate that there are about 10–12 S—S bonds in the molecule.) Previous measurements of molecular weights further indicate that the molecule is split roughly in half during this conversion[4].

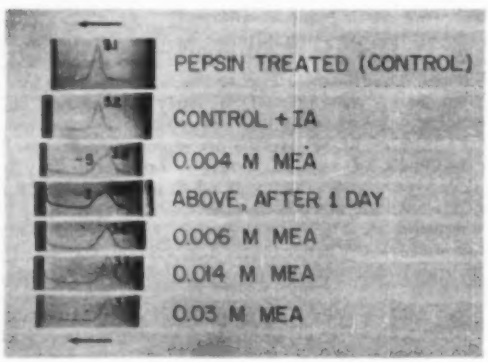

Fig. 1. Effect of 2-mercaptoethylamine hydrochloride (MEA) on the sedimentation characteristics of a purified peptic digest of rabbit antiovalbumin γ-globulin. Photographs taken 67 min. after attainment of full speed (59,780 r.p.m.) in the Spinco model *E* ultracentrifuge. The abbreviation IA refers to iodoacetamide. Each sample except the control contained 0·04 *M* iodoacetamide. Each solution also contained 0·1 *M* sodium acetate, adjusted to *p*H 7 with acetic acid. Details of procedures are given in the text. The S_{20w} value is indicated near each peak

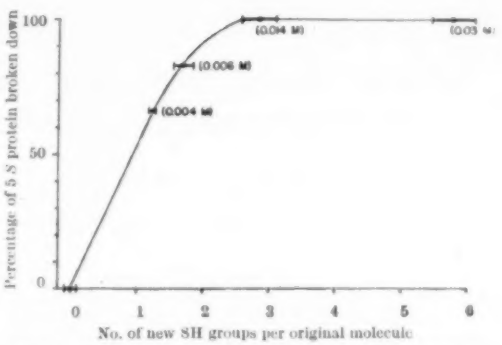

Fig. 2. Effect of 2-mercaptoethylamine hydrochloride (MEA) on a purified peptic digest of rabbit antiovalbumin γ-globulin. The molarity of MEA used is given on the graph. Each reaction was carried out for 1 hr. at 37° as described in the text

Another characteristic of the conversion is that the molecule loses its capacity to precipitate specifically and acquires the ability to block precipitation in the homologous precipitin reaction[1,5]. There is strong evidence that this is attributable to the univalence of the fragments resulting from treatment with a disulphide-splitting reagent[5]. In the present experiments a portion of each sample tested in the ultracentrifuge was dialysed overnight against 4 litres of the cold saline–borate buffer described above. The protein concentration was adjusted to 8 mgm./ml. and 0·25 ml. portions (2 mgm.) were tested in duplicate for their effect on the precipitation of 1·4 mgm. of untreated antiovalbumin γ-globulin with slightly less than an optimum concentration of ovalbumin, in saline–borate buffer, *p*H 8. Each solution contained 40 μgm. of antigen and the total volume was 0·65 ml. Mixtures were refrigerated for five days. In the absence of fragments, 335 ± 7 μgm. of precipitate was formed. In the presence of the samples treated with 0·006 *M*, 0·014 *M* or 0·03 *M* MEA, no precipitate was formed. The sample treated with 0·004 *M* MEA caused a reduction from 335 to 265 ± 6 μgm. of precipitate. This partial blocking may be ascribed to the fact that the sample was only partially reduced.

None of these preparations caused any significant inhibition in a heterologous reaction, that of bovine γ-globulin reacting with its rabbit antibody to yield 310 μgm. of precipitate. One of the preparations (reduced with 0·006 *M* MEA) caused an increase of 25 per cent in the amount of precipitate formed in the heterologous system. The reason for this apparent enhancement is not known.

None of the MEA-treated samples formed a precipitate when mixed with an amount of antigen that was optimal for the untreated 5 *S* protein, or

with one-fourth this quantity of antigen. The limited amount of material available prevented further testing. However, previous work has shown that the 3·5 *S* protein does not form specific precipitates when tested with a wide range of antigen concentrations[5].

In another control experiment it was found that treatment with 0·04 *M* iodoacetamide at *p*H 5, followed by dialysis, had no significant effect on the amount of precipitate formed by a given weight of the pepsin-treated antibody preparation used in these experiments.

There is considerable evidence[6] suggesting that the univalent fragments formed by reduction of the peptic digest of rabbit antibody correspond to Porter's fractions I and II. The present results suggest that these fractions are linked in the antibody molecule by a single, highly reactive disulphide bond. The results do not preclude the possibility that additional bonds, hydrolysed by pepsin, also link these sub-units, or that other, weaker bonds may be involved.

This work was supported by Grant *E*-2858 from the National Institutes of Health.

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EFFECTS OF ŒSTROGEN ON SOMATIC VARIATION OF AN ERYTHROCYTE AGGLUTINOGEN IN CHICKENS

By S. L. SCHEINBERG and R. RECKEL

U.S. Department of Agriculture, Agricultural Research Service, Beltsville, Maryland

SOMATIC variation of a permanent nature may arise from admixture of erythropoietic tissue during fœtal life[1]. More recently, somatic mutation has been proposed to explain the presence of a low frequency of inagglutinable cells in a population composed predominantly of agglutinable cells[2,3]. Somatic variation may also arise from events of a more transient nature, such as the coating of red cells by plasma as occurs in the '*J*' substance of cattle[4] and the '*R*' substance of sheep[5]. Evidence has been obtained that a hormone also plays a part in somatic variation of a red cell agglutinogen.

A survey of 69 seed extracts which could be used as typing fluids for chicken red cells was carried out with the following results: 64 per cent did not react with the red cells of any of the chickens tested; 9 per cent agglutinated the red cells of all chickens tested; 5 per cent hæmolysed the red cells of all chickens tested and 22 per cent detected differences among individual chickens, 20 or more birds being used in these tests. Among the extracts which could distinguish the cells of individual chickens, those from *Lathyrus cicera*, the falcon pea, and *Pisum arvense*, the Canadian field pea, gave identical reactivities with all birds tested; the substance detected by these extracts was designated 'H_i'. These extracts were found to agglutinate only the red blood cells of females. There were 54 males tested and all were found to be without reactivity; however, the cells of 75 of the 129 females tested were found to be reactive. Reactivity on the red cells was detected when the females reached sexual maturity. Among 7 females tested all became reactive after the onset of egg-laying and maximum macroscopic agglutination scores were reached from 14 to 31 days.

A number of correlative studies (62) were carried out in which chickens were typed monthly or more frequently and the cumulative egg production recorded from one test period until the next. On the basis of these results the hens were placed in three classes; those which were laying or which had laid and whose cells were reactive; those that had never laid and whose cells had never shown reactivity; and the third class consisting of those hens whose cells were non-reactive regardless of the condition of laying. One bird was found the cells of which were reactive but which had not laid any eggs. An autopsy of this bird showed that she was an internal layer, for there were a large number of yolks in the body cavity; therefore, this bird properly belongs in the first category.

Table 1. Comparison of Reactivities of Terminal Red Cells with Bone Marrow Cells of No. *M*5792

	L. cicera		*P. arvense*		Saline or egg albumen	
	Terminal red cells	Bone marrow cells	Terminal red cells	Bone marrow cells	Terminal red cells	Bone marrow cells
11 days after ovariectomy	2–3	(+)	3–4	+	0	0
28 days following ovariectomy	0	—	0	—	0	0
4 days after treatment with diethylstilbœstrol	(+ – 1)	2–3	(+ – 1)	3–4	0	0
	In titrations with *P. arvense*					
	Undiluted	1 : 2	1 : 4	1 : 8	1 : 16	1 : 32
11 days after ovariectomy						
Bone marrow cells	+	+	+	(+)	0	0
Terminal red cells	– 4	3–4	2–3	2–3	2	0
4 days after treatment with diethylstilbœstrol						
Bone marrow cells	2–3	2–3	2–3	1–2	(1–2)	0
Terminal red cells	(+)	(+)	*	0	0	0

Dashes indicate that tests were not carried out; values in parenthesis are microscopic scores; * refers to a questionable reaction.

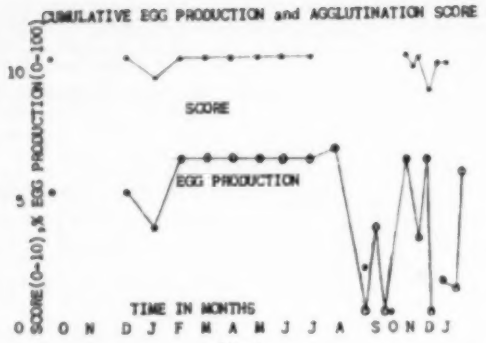

Fig. 1

Fig. 1 presents the results obtained over a period of months with one of the 62 birds under investigation; where the line is not continuous this indicates that information either on agglutination or egg production was not obtained for that date. It is evident that there is a relationship between egg-laying and the presence of the agglutinogen, since the score rises and falls when the egg production rises and falls and remains constant when the egg production is constant. There is a lag, however, between change in score and change in egg production which is most clearly seen for the month of January, when weekly and bi-weekly testing was carried out. A similar lag was observed when birds began egg-laying. The present hypothesis is that the lag was a consequence of transformation to agglutinability which occurs in the bone marrow. Evidence for this hypothesis is presented in Table 1. As expected, under the replacement hypothesis bone marrow was found to be less reactive when the bird was ovariectomized and the terminal red cells were decreasing in reactivity but were still reactive, and, conversely, when the terminal red cells were low in reactivity immediately following the injection of œstrogen, the bone marrow cells were more reactive. Similar experiments have been carried out with other birds, and analogous results were observed in birds beginning to lay or going out of egg production.

The basis for the association between egg-laying and the occurrence of the 'H_i' substance appears to be hormonal. In Fig. 2 it may be seen that the agglutination score decreases to zero following ovariectomy. When injections of diethylstilbœstrol were made, agglutinability increased and when injections of the hormone were discontinued the agglutinability of cells declined. Injection of corn oil (the hormone solvent used) in an ovariectomized bird did not result in a rise in agglutinability, whereas injections of hormones in two other ovariectomized birds gave marked increases in agglutinability as observed with No. *N*5792. All of these results paralleled the increase in agglutinability observed when birds began to lay or were coming back into egg production following a pause.

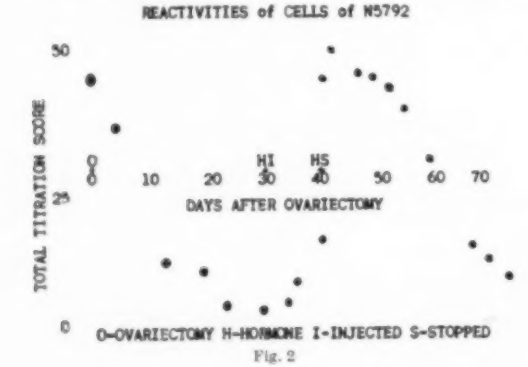

Fig. 2

Preliminary results from pedigree data indicate that the variation observed among the females with respect to the agglutinogen 'H_i' also has a familial basis. Pedigree data were obtained from laying birds the red cells of which were non-reactive and from laying birds the cells of which were reactive. Matings of non-reactive hens from a highly inbred line, from which all the hens tested were non-reactive, gave rise to 29 female progeny, all of which were non-reactive. Four other hens from the same line which were reactive gave rise to 29 female progeny, all of which were non-reactive. Four other hens from the same line which were dead at the time of typing had a total of nine female progeny all of which were non-reactive. The three sires were from lines in which the females were non-reactive and one male was closely related to all the dams. Since it had been shown that diethylstilbœstrol can cause an increase in agglutinability in females which were known reactors, it was of interest to determine whether the presumed genetically non-reactive birds could become reactive if the œstrogen-level were increased. Two females from the non-reactive progeny which were laying were given 16 injections of diethylstilbœstrol, each injection consisting of 0·53 mgm.; a third female, also laying from the same group, was given corn oil. The red cells of these three birds have remained non-reactive during the entire period of testing. These results suggest that there may also be differences in the red cells of the reactive and non-reactive birds not primarily due to the influence of hormone.

Some results were also obtained from test-cross types of matings which demonstrate segregation in the offspring of some reactive hens. Sires were from families in which the female sibs or maternal parent were reactive and such males were mated to non-reactive hens. The reciprocal matings were also made. A total of seven sires were mated to eleven dams and from these matings 12 reactive and 18 non-reactive female progeny were obtained. Results were also obtained from matings (4 sires, 14 dams) in which the hens were not available for typing (they were either dead or had been culled) and the males were from lines in which the hens were reactive. Such matings produced 14 reactive female progeny, 18 non-reactive female progeny and 3 progeny of questionable reactivity.

These observations suggest that the variation observed among the laying hens with respect to the 'H_i' substance is a function of the genotype and a hormonal factor extrinsic to the red cells.

The results presented here will be treated more fully elsewhere. We thank Prof. M. R. Irwin for suggestions in the preparation of this communication.

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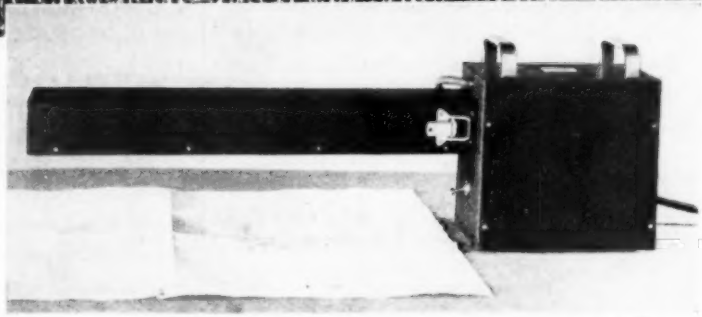

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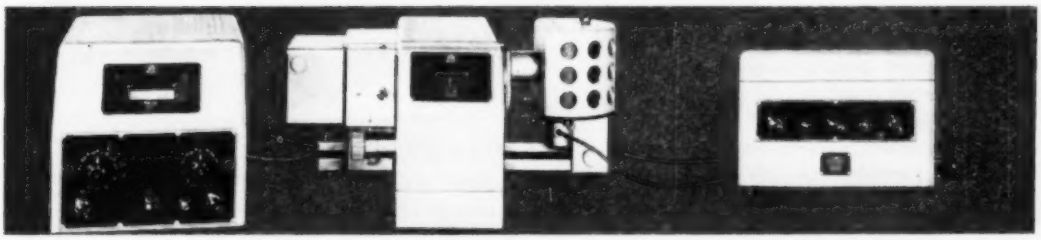

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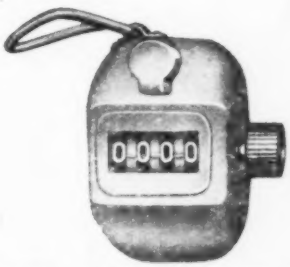

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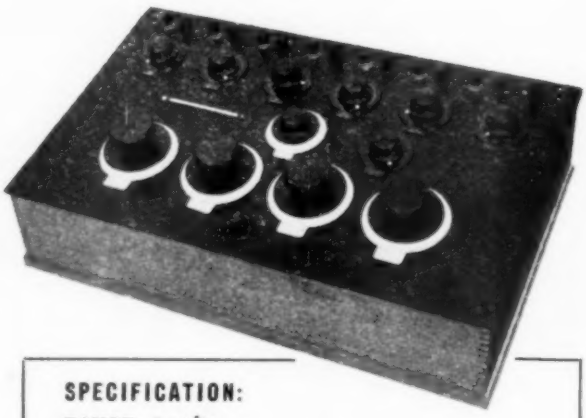

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LETTERS TO THE EDITORS

PHYSICS

Space-Charge Currents in Gallium Arsenide

Mott and Gurney[1] pointed out that an insulator should be able to carry an electronic current if electrons were injected into it by a suitable contact. Such currents were observed experimentally by Smith and Rose[2] in cadmium sulphide crystals. They showed that an essential condition was that the 'deep trap' density should be low, deep traps being centres with energy-levels well below the conduction band which can accept electrons. In a recent communication[3] a model was proposed to account for the properties of semi-insulating gallium arsenide. The model suggested that in this material the above condition should be satisfied, and as a result it was predicted that space-charge currents should be observable. Here we present experimental results confirming the correctness of the prediction.

Wafers of semi-insulating gallium arsenide were prepared from bulk ingots by cutting, grinding and etching. Typical dimensions were $3 \times 3 \times 0{\cdot}15$ mm. Tin contacts of 0·5 mm. diameter were alloyed at the centres of the two large faces. This configuration makes any surface leakage paths between contacts long. A current-voltage plot taken under d.c. conditions at room temperature for one such specimen is shown in Fig. 1. In the region in which current increases rapidly there were some changes with time, and Fig. 1 shows steady-state values.

Lampert[4] has given the theory for space-charge currents when a single trap-level is present, and we may readily adapt his theory to our model for gallium arsenide. At low voltages any injected charge is trapped, and to a good approximation Ohm's law is obeyed. At high voltages space-charge due to traps is small compared with that due to injected carriers and the variation of current with voltage is given by the solid-state analogue of Child's law[1]:

$$I = \frac{9}{32\pi} \frac{\varkappa\mu V^2}{L^3} \qquad (1)$$

The ohmic and space-charge regions are connected by a region in which the current increases by several orders of magnitude for a small change of voltage. The voltage at which this occurs, called by Lampert the 'traps-filled-limit' voltage, is just the change in potential produced by the space-charge of the filled traps, that is:

$$V_{TFL} = \frac{2\pi e}{\varkappa} L^2(N_A - N_D) \qquad (2)$$

For the specimen the characteristic of which is shown in Fig. 1 the magnitude of the space-charge current agrees with that given by equation 1 within a factor three, which is within the limits of experimental error. Since in this case the thickness L was 0·12 mm., the unfilled trap density $N_A - N_D$ is found from equation 2 to be 8×10^{16} cm.$^{-3}$.

For another specimen from a different ingot the value V_{TFL} was measured and found to be 60 V.

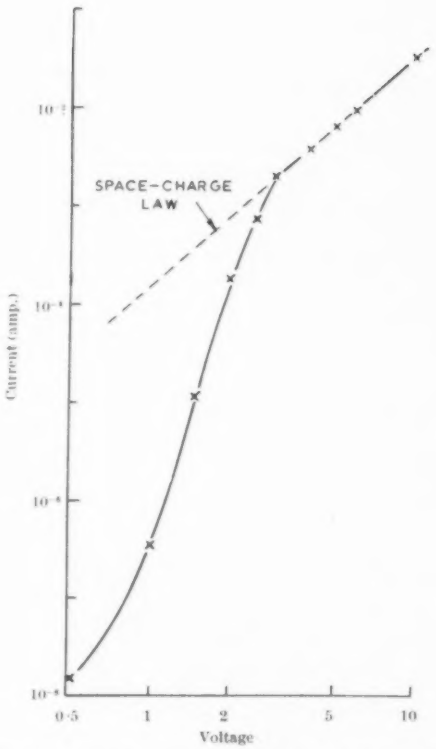

Fig. 1. Current-voltage curve for gallium arsenide showing ohmic and space-charge regions

Mr. N. A. C. Thompson, of this Laboratory, has measured the resistivity and Hall effect as a function of temperature for specimens cut from the same ingot. From equation 2 we determine $N_A - N_D$ at room temperature to be $3{\cdot}8 \times 10^{12}$ cm.$^{-3}$. Applying the analysis of ref. 3 to Mr. Thompson's measurements, we find $\chi - 1$, which measures the proportional departure from exact compensation, to be 5×10^{-6}. Now:

$$N_D = \frac{N_A - N_D}{\chi - 1} \qquad (3)$$

so by combining space-charge and Hall effect measurements we find N_D, which for this particular specimen turns out to be 8×10^{17} cm.$^{-3}$, a rather high value but not improbably high.

Thus a model in which acceptors at a level deep in the energy-gap are auto-compensated by shallow donors seems a reasonable first approximation in explaining not only the Hall effect but also the space-charge currents in semi-insulating gallium arsenide. It would be interesting to know if a similar mechanism could explain the low trap density observed in cadmium sulphide, but the relevant measurements of

carrier concentration as a function of temperature do not seem to be available.

We wish to express our thanks to Mr. N. A. C. Thompson for the use of his experimental results. Acknowledgment is made to the Admiralty for permission to publish this communication.

J. W. Allen
R. J. Cherry

Services Electronics Research Laboratory,
Baldock, Herts.

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Hyperfine Splitting of Rubidium-87

Rubidium has been used in the development of gas cell frequency standards, and from measurements of the variation of frequency with the pressure of the buffer gas used in the cell it has been deduced[1] that the frequency corresponding to zero gas pressure is :

6 834 682 608 c./s. ± 7 c./s.

where the second of time is that giving 9 192 631 770 c./s. for the cæsium hyperfine structure splitting at zero field[2]. It has been found, however, that when cæsium is used in a gas cell the extrapolated frequency is 30 c./s. lower than the value given above obtained by an atomic beam experiment[3]. There is therefore considerable interest in the atomic beam value for rubidium. For this purpose the oven of the long beam chamber[4] at the National Physical Laboratory was filled with a mixture of rubidium-87 and cæsium-133. A strong beam of atoms was obtained at an oven temperature of 120° C., and the application of the appropriate radio frequency produced, alternatively, resonances of the rubidium or cæsium atoms. The amplitude of the cæsium resonance was 50 per cent greater than that of rubidium, the higher vapour pressure of cæsium presumably compensating for the fact that a greater proportion of the rubidium atoms take part in the resonance. In both cases the signal to noise ratio was adequate for the precise measurement of the frequencies corresponding to the resonance peaks. The rubidium resonance, which was 71 c./s. wide, was excited in cavities independently tuned and separated by a distance of 254 cm. It was slightly asymmetrical, but the asymmetry was measured and a correction applied. The value on the atomic time-scale corrected for the asymmetry and magnetic field is :

6 834 682 614·0 ± 1 c./s.

It is proposed to continue measurements of the two atomic transition frequencies.

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L. Essen
E. G. Hope
D. Sutcliffe

National Physical Laboratory,
Teddington, Middlesex.

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Whisker Growth from Quartz

Whisker growth and associated phenomena have been extensively reviewed recently by Messrs. N. F. R. Nabarro and P. J. Jackson[1]. They cited observations of growth from metallic oxides, sulphides and hydroxides along with the more usual growth in metals. Whisker growth from fused quartz, apparently an unreported phenomenon, is unusual due to the vitreous nature of the substrate.

The whiskers are shown in Fig. 1. Large single whiskers and clusters of shorter ones grew from discrete places on the substrate. The quartz was heated in a 'Zirco' tube through which flowed 1 litre/min. of dry nitrogen. The temperature was approximately 1,425° C. and time for the growth was 24 hr. Immediately adjacent to the whiskers was a dense patch of pine tree-like dendrites. The whiskers ranged in length from millimetre to micron size.

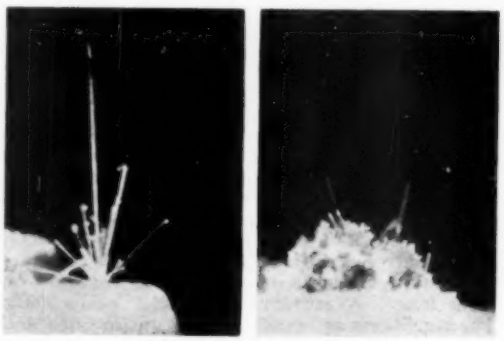


Fig. 1. Quartz whiskers. (× 15)

The quartz substrate from which these whiskers grew had a skin of devitrified quartz covering its surface due to regular use at elevated temperatures. There was silicon material placed on the substrate near the growth area. There is no apparent evidence to point to how the whiskers grew either from the base or at the tip. However, the devitrified skin afforded the conditions for nucleation.

Further work and mechanical tests will be undertaken on these whiskers.

R. J. Jaccodine
R. K. Kline

Bell Telephone Laboratories, Incorporated,
Allentown,
Pennsylvania.

[1] *Proc. Int. Conf. Crystal Growth*, 13 (J. Wiley and Sons, 1958).

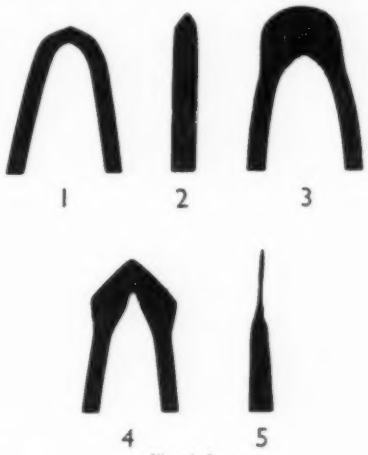
Simple Methods for preparing Pointed Filaments for the Electron Microscope

The performance of electron guns used in the electron microscope has been studied by Haine and Einstein[1], Boersch and Born[2], and others. The present indications are that pointed filaments improve this performance. The first of these filaments was prepared by Hibi[3] by hand-polishing or etching a short length of tungsten wire which was welded or otherwise attached to a conventional hairpin filament according to Müller's method[4]. Heating was obtained by conduction from the hairpin.

The main disadvantage of the Hibi filament is that it is difficult to prepare and much may depend on the skill of the operator. The present communication describes a very simple method by which pointed filaments may be quickly prepared by any operator.

The basis of the method is to make a point on a conventional hairpin filament. This may be achieved in two ways, either by straightforward grinding or by pinching to make the filament thinner at the tip, followed by grinding. Details of the methods are as follows :

(1) A small disk of fine emery paper (grade 'Corosil' 600 or 000), about 3 cm. in diameter, is stuck to a metal disk and fitted to an electric motor which can revolve at 1,000–3,000 r.p.m. Four flats are ground, according to Figs. 1 and 2. The angles are not critical but should be about 120° in the front view (Fig. 1) and 70° in the side view (Fig. 2). Grinding is facilitated if a low-power lens is used and the following sequence is adopted : (*a*) Grind the faces in Fig. 1 so that a sharp point is obtained. Material is removed rapidly in this case. (*b*) Grind the faces in Fig. 2. More time is required to produce a point in this case. (*c*) Inspect under a × 10 lens, and if the point appears blunt from the front (Fig. 1) touch the faces on the revolving disk for a very short time. (*d*) Inspect the filament from the side (Fig. 2) and if this point appears blunt regrind very lightly.



Figs. 1–5

With a little practice a sharp point can be obtained in about 2 min. Care must be taken not to grind away more than half the diameter of the wire or premature burn-out will occur. This type of filament will be referred to as a ground filament.

(2) A much sharper point can be obtained by pinching a filament (not pre-heated *in vacuo*) at the tip before grinding, using a pair of smooth-faced pliers ; the filament tip is inserted so that only about 0·5 mm. is gripped by the pliers. After exerting a sufficiently high pressure the tip will be plastically deformed to the shape shown in Figs. 3 and 5, the latter showing that it is in the form of a thin foil. Before removing the filament from the pliers it is desirable to ensure that the deformed tip has not been bent over, otherwise it must be straightened. It is important that the pliers should be properly hardened, otherwise the tip will not be flattened sufficiently.

Grinding is carried out with the same assembly as before, but it is desirable to use a finer grade of emery paper. A suitable sequence is as follows: (*a*) Touch the foil faces against the rotating wheel to produce the fine point shown in Fig. 5. (*b*) Grind a point subtending an angle of about 90° on the foil periphery (Fig. 4). (*c*) If the point shown in Fig. 5 has become blunt on inspection with a × 10 lens, regrind very lightly. (*d*) Retouch the other two faces if necessary.

The process can be carried out in 2 or 3 min., as the grinding is easier to carry out than in the first method. These filaments will be referred to as pinched filaments.

Consideration of the following general points may help to ensure satisfactory results: The lens used to view the grinding wheel must provide a magnification of about × 5. A telescope is satisfactory, provided that the image is not inverted, otherwise the handling of the filament becomes very difficult. The use of a rheostat to vary the motor speed is valuable if there is a tendency to grind away too much material from the tip. If a large number of filaments are to be made, it may be convenient to make up a simple jig with a swinging arm to hold the filament. Mounting the filament in a metal block will facilitate handling and improve grinding accuracy if a jig is not to be used. Filaments with a sharp bend at the tip give best results.

It is obvious that there is little flexibility in the way a filament can be ground, except perhaps in the case of the pinched type. Here some variation of angle

Fig. 6

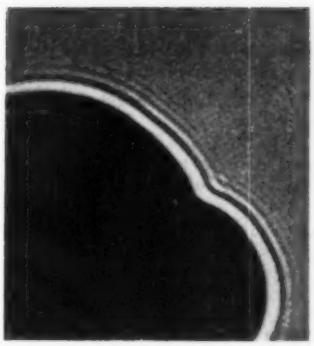


Fig. 7

and amount of material removed can be achieved, though generally with little effect on performance.

Before use, both types of filament should be heated to 2,500° C. *in vacuo*. It is, of course, very important that nothing should be allowed to touch the point, otherwise it will be damaged and the efficiency of the filament impaired.

The centring of the Hibi type of filament is critical, and this is also the case with ground and pinched filaments. All filaments have a tendency to move to a certain extent so that, particularly during the first few minutes of operation, it will be found that the electron gun requires frequent re-alignment. Some trouble can be saved by turning both filament and H.T. supplies on for a few minutes before operation; this will give the filament a chance to settle into a stable position.

The Hibi filament provides increased coherence in the electron beam, which is also the case with ground and pinched filaments. This is demonstrated by Figs. 6 and 7, which are electron micrographs (×180,000) of under-focused Fresnel fringes taken with standard and pinched filaments respectively. Both condenser lenses were switched off for these experiments in order to have easily reproducible illumination conditions. On the original prints, three fringes were visible with the standard filament, and five with the ground and pinched types.

The increased brightness may be due to either an increased source temperature or to a reduction in space-charge effects on the emission. The temperatures of these pointed filaments have not yet been measured so that a full explanation cannot be attempted. In general, qualitative observations agree with the detailed results of Swift and Nixon[5].

I am grateful to Mr. T. Mulvey for valuable help and discussion, and also to Dr. T. E. Allibone, director of the Laboratory, for permission to publish this communication.

D. E. Bradley

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METALLURGY

Production and Mobility of Point Defects in Titanium and Zirconium

Electrical resistivity measurements have been made by many workers on quenched, irradiated or plastically deformed metals, in order to study the production of defects by these various treatments. By observing the recovery of the resistivity on annealing, it is possible to study the mobility of the various defects out of the material or to internal sinks. In this communication we present some results on the mobility of defects, introduced by low-temperature plastic deformation in titanium and zirconium.

Polycrystalline titanium and zirconium wires (of a purity of about 99·9 weight per cent), were strained in tension at 78° K., and the extra resistivity introduced by the plastic strain was measured at the test temperature as a function of the strain. The increase in resistivity expressed as a percentage of the original resistivity at 78° K. was approximately 8 per cent for titanium and 5 per cent for zirconium, both due to a tensile strain of 6 per cent. Strained wires were then annealed for 15 min. at 78° K., 195° K. and room temperature, the resistivities after each anneal being measured at 78° K. After the room-temperature anneal, more than 50 per cent of the extra resistivity introduced by the plastic deformation was annealed out in the case of titanium, whereas the corresponding value for zirconium was 30 per cent. These recoveries of resistivity showed that there was appreciable mobility of defects below room temperature, these having been produced by plastic deformation. In the case of zirconium, such mobility has been observed previously for defects produced by irradiation; for Zartman[1] has bombarded zirconium with deuterons at 170° K. and observed a 60 per cent recovery of electrical resistivity on annealing at room temperature.

A very surprising feature of this work was that, for titanium, the resistivity was in fact recovering at the temperature of deformation, 78° K. This effect was not observed in zirconium, but we believed that in this case the recovery might occur too rapidly to be detected by annealing tests at the temperature of deformation.

To test this possibility, wires of both titanium and zirconium were strained in tension at 20° K., and the extra resistivity introduced by the plastic strain was measured at 20° K. as a function of the strain. The increase in resistivity expressed as a percentage of the original resistivity at 20° K. was approximately 30 per cent for titanium and 60 per cent for zirconium, both due to a tensile strain of 6 per cent. The wires were then annealed for 15 min. at 20° K., 78° K. and room temperature, the resistivities after each anneal being measured at 20° K. It was observed, both for titanium and zirconium, that whereas there was apparently no recovery at 20° K., approximately 20 per cent of the resistivity introduced by the 20° K. deformation was recovered after the 78° K. anneal.

This recovery, at temperatures below 78° K., of resistivity introduced by plastic deformation in the hexagonal metals titanium and zirconium, is in marked contrast to the behaviour of the face-centred-cubic metals, copper, nickel and gold, where there is essentially no recovery of resistivity after plastic deformation at low temperatures[2]. In these metals, recovery of resistivity below 78° K. is only observed after very heavy deformation, when some slight recovery does occur in the temperature interval up to 78° K., the recoverable fraction of the resistivity increasing with increasing strain. Of course, there is substantial annealing in the face-centred-cubic metals below 78° K. (the so-called stage I), when the damage giving rise to the resistivity is caused by irradiation with electrons, deuterons or neutrons[3].

Although it may not be altogether valid to compare energies for the movement of various defects in the hexagonal and face-centred-cubic structures, or to compare the temperature ranges in which they move, it is interesting to speculate why there is a difference between the two structures. It would seem that, in our experiments, isolated interstitial metal atoms are produced by plastic deformation, and that

these then migrate at the low temperatures involved; whereas in the case of the face-centred-cubic metals the experimental evidence indicates that they are not produced[4]. This difference might be related to a difference in stacking fault energies, for in the hexagonal case where slip occurs mainly on the {10$\bar{1}$0} prism planes, the dislocations should have a relatively high stacking-fault energy, probably much higher than copper, nickel or gold. Support for this idea is provided by the results obtained for aluminium[5], a face-centred-cubic metal with a very high stacking-fault energy; for Sosin and Koehler have found that if aluminium single crystals are deformed in tension to an elongation of 15 per cent at 4° K., then there is a 10 per cent recovery of resistivity on annealing at 78° K. One would expect the effect to be much greater for poly-crystals, where the operation of intersecting slip systems can cause increased production of point defects.

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Initiation of Fatigue Cracks in Beta-Brass

Fatigue cracks have been seen to be initiated in slip bands, twin boundaries and grain boundaries, in a number of investigations on the fatigue behaviour of metals[1-3].

During recent work on the fatigue behaviour of beta-brass a different mode of fatigue crack initiation has been observed, which has not been reported previously in the literature. Certainly, it does not occur in the case of fatigued copper.

Beta-brass was chosen because of the lack of knowledge of the fatigued behaviour of body-centred cubic metals. Polycrystalline material, with an average grain-size of 2 mm., has been fatigued in reverse plane bending at a frequency of 8,400 c./min. Specimens in the form of cantilevers were mechanically polished with care and finally electro-polished prior to fatiguing.

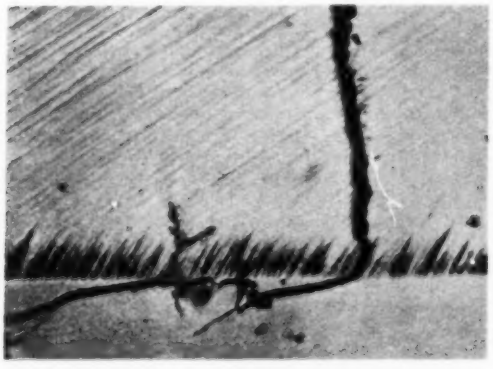

Fig. 1. Surface of fatigued beta-brass specimen. Fatigue cracks initiated in short slip markings adjacent to one side of a grain boundary. Oblique light. (× *c.* 1,860)

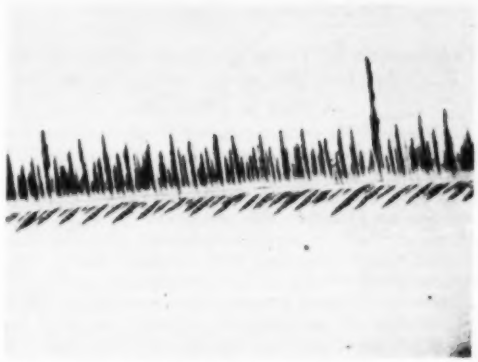

Fig. 2. Surface of fatigued beta-brass specimen. Extrusions on short slip markings adjacent to both sides of a grain boundary. (× *c.* 1,070)

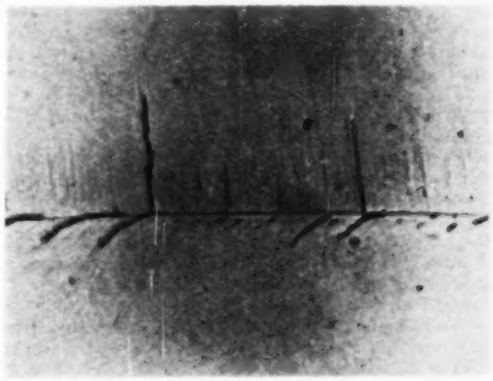

Fig. 3. Surface of fatigued beta-brass specimen. The same area as shown in Fig. 2 after extrusions and slip removed by electro-polishing. Persistent markings, that is, incipient cracks. (× *c.* 1,070)

One of the main observations has been the initiation of fatigue cracks and the formation of extrusions in short-slip markings, which form adjacent to grain boundaries, and in the majority of cases at an angle to the main slip. These cracks are afterwards propagated into and across the grain boundaries and frequently become linked together.

The most unusual features of this phenomenon are that these cracks form at an angle to the main slip but not in the main slip, and that they form adjacent to the grain boundaries but not in the grain boundaries (Figs. 1, 2 and 3).

Further work leading to a model for the mechanism is in progress.

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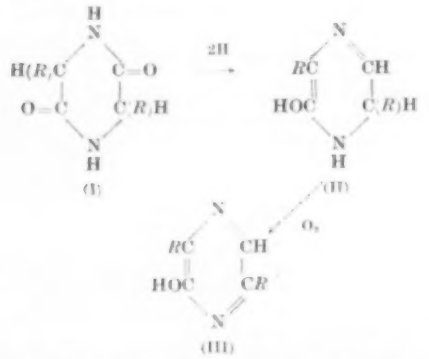
RADIATION CHEMISTRY

Production of Pyrazine Derivatives in the Radiolysis of Aqueous Solutions of the Cyclic Dipeptides

Radiation-induced reactions in aqueous solutions of amino-acids, peptides, and related compounds have been treated in a number of reports from this Laboratory[1]. In connexion with this work, we have had occasion to examine the effects of γ-irradiation on the ultra-violet absorption spectra of solutions of various simple peptides. The measurements reveal that solutions of the cyclic dipeptides under specific conditions exhibit pronounced and characteristic post-irradiation changes. If, for example, an oxygen-free solution of alanine anhydride is irradiated and examined spectrophotometrically, the differential spectrum (read against unirradiated solution) shows negligible absorption above 2600 Å. so long as the solution is not exposed to the atmosphere. However, if oxygen is introduced, an absorption maximum in the longer wave-length region slowly appears. This post-irradiation change is accelerated by addition of either acid or base. In neutral and basic solution the absorption maximum is at about 320 mμ; in acid solution the maximum shifts to 340 mμ. This shift is reversible, and the evidence is that the final yield of the absorbing species is essentially independent of the *p*H of the solution during the post-irradiation oxidation. Solutions of glycine anhydride exhibit quite similar properties except that the wave-length of maximum absorption (320 mμ) is independent of *p*H. It is also to be noted that these post-irradiation changes are not observed if oxygen is present during irradiation.

We believe the phenomenon involves the radiation-induced reduction (and subsequent dehydration) of the diketopiperazine molecule (I) to the corresponding 1 : 2-dihydropyrazine derivative (II) which is of a class of compounds known[2] to be readily oxidized (that is, in air) to the corresponding pyrazine structure (III)



Isolation of 2-hydroxy-3 : 6-dimethylpyrazine (III) from an irradiated solution of alanine anhydride (Nutritional Biochemicals Corporation, Lot 2104, recrystallized three times from water) has been effected. The irradiated solution was lyophilized, and an appropriate aliquot of a methanolic solution of the residue was transferred to a filter-paper strip, and then chromatographed in a butanol–ammonia solvent system[3]. At low radiation dosages a single fluorescent compound ($R_F \sim 0{\cdot}7$) was observed.

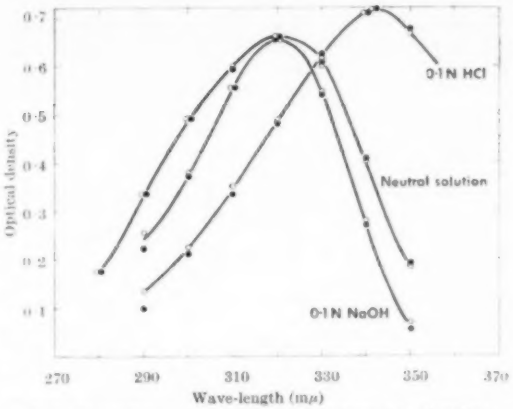


Fig. 1. Absorption spectra of authentic 2-hydroxy-3 : 6-di-methyl-pyrazine (○) and of product isolated from irradiated solutions of alanine anhydride (●)

This was eluted and compared spectrophotometrically with authentic material prepared according to the method of Baxter and Spring[4]. Fig. 1 shows a normalized plot of the results. Co-chromatographic studies of the authentic material and the isolated irradiation product fully support the identification. The initial yield of 2-hydroxy-3 : 6-dimethylpyrazine in 0·1 *M* alanine anhydride corresponds to a *G*-value of $\sim 0{\cdot}4$ (cobalt-60 γ-rays; 7×10^{19} eV./ml.).

This work was performed under the auspices of the U.S. Atomic Energy Commission.

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CHEMISTRY

Porous Glass Chromatography

Chromatographic separations have now been achieved using porous glass[1] as a medium. Its extreme inertness, optical transparency, and small pore diameter (about 4 mμ) suggested this usage. Initial results strongly indicate that unusually fine chromatograms can be obtained with this material. Other than in the choice of medium, there is little difference between the techniques described here and those commonly used in paper chromatography.

The present investigation has been concerned with the characterization of fountain-pen inks. The procedure is quite simple, consisting essentially of four steps. First, a 2-μl. sample of ink is placed about one-half of an inch from the edge of a small (3 in. × 3 in.) piece of porous glass. Secondly, the glass is exposed to the vapours of the liquid solvent to be used for development for 1 hr. Thirdly, the sample edge of the glass is dipped into the solvent almost up to the spot of ink and held in this position

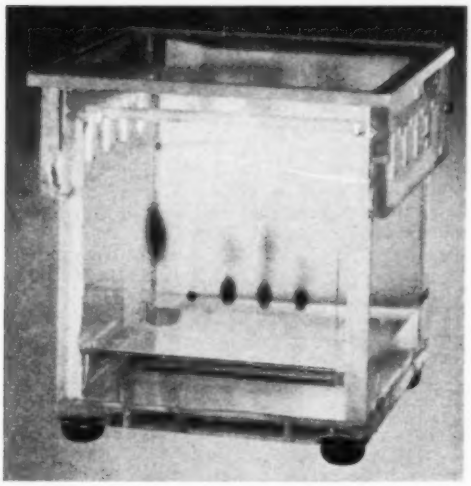

Fig. 1. Chromatographic cell

for about 24 hr. as shown in Fig. 1. Fourthly, and lastly, the glass is removed, wiped dry with a soft cloth, and placed in a warm place to remove completely the absorbed moisture.

Chromatograms resulting from this procedure have yielded excellent separation of the individual constituents depending on their relative solubilities, molecular size and shape, and relative retardation effect to the porous medium. Examples of chromatograms of five ink samples are illustrated in Fig. 2.

Unfortunately, a black-and-white reproduction of these porous glass chromatograms does not do justice to the colourful results which were actually obtained. Sample No. 41, for example, Carter's 986 black ink, resulted in a blue spot where the original sample was placed, a deep green over this, followed by orange and finally a rose or violet on top.

The other inks shown in Fig. 2 are identified: No. 38, Waterman's new permanent black; No. 39, Waterman's old permanent black: No. 42, Higgin's No. 812 eternal permanent black; No. 50, Carter's No. 99 permanent black.

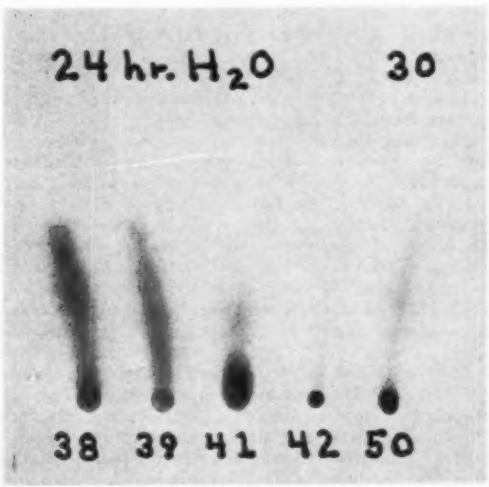

Fig. 2. Porous glass chromatogram

There are several advantages in the use of porous glass as compared to conventional paper for a chromatographic medium. Very high surface area of porous glass (about 150–200 m.² per gm.) confines the sample to a small area due to immediate drying. This, in addition to longer development time, provides improved resolution or definition of the bands. Porous glass can be used with nearly all solvents except hydrofluoric acid and strong alkaline solutions. Being an inorganic inert material, organic contamination is at a minimum and pyrolysis rates of specific components have been observed as individual bands changing in appearance. Porous glass chromatograms can be permanently filed for reference. Optical measurements, including transmission, reflectance and fluorescence, have been made directly on the dry, transparent porous glass after the chromatographic separations have been accomplished.

The original interest in the use of porous glass as a chromatographic medium has been a result of my interest and activity in the field of criminology. It must be pointed out, however, that this medium is not in any way limited to the characterization of fountain-pen inks. The separations and/or purification of body fluids, virus, bacteria and other serological fluids which may be obtained due to their actual molecular dimensions must be investigated. Observations have been made which establish the fact that certain molecules are too large to pass through the small holes in porous glass. Finally, the use of this medium as a support for electrophoretic separations offers possibilities as yet unexplored.

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Two New Amino-Sugars from an Antigenic Polysaccharide of *Pneumococcus*

THOUGH a large number of antigenic capsular polysaccharides of *Pneumococcus* are known to contain one or more amino-sugars[1], in only one case, namely, 2-amino-2-deoxy-D-glucose (D-glucosamine) from type XIV polysaccharide[2], has the amino-sugar been isolated and characterized. Two amino-sugars, designated 'pneumosamine' and 'amino-sugar X', have been isolated from purified Type V *Pneumococcus* capsular polysaccharide[3], and preliminary investigations, which included analysis of the crystalline *N*-acetamido alcohol derivatives, indicated that both sugars were 2-amino-2,6-dideoxyhexoses. Kuhn-Roth determinations on '*N*-acetylpneumosaminol' (1·52 moles CH_3) and on 'amino-sugar X' (0·68 mole CH_3) support the postulated 6-deoxyhexosamine structure. The sugars have now been tentatively identified as 2-amino-2,6-dideoxytalose (pneumosamine) and 2-amino-2,6-dideoxy-L-galactose (amino-sugar X). The sugars were isolated from a polysaccharide hydrolysate (hydrolysis conditions: 2 *N* hydrochloric acid, 24 hr., 100°) by chromatography on 'Dowex-50' resin[4]. The acidic effluents were neutralized with 'Deacidite *FF*' (carbonate form), lyophilized and the syrupy residues dried *in vacuo* over phosphorus pentoxide. Treatment of the 'pneumosamine' residue with methanol gave 'pneumosamine hydrochloride' melting point 162–3° (from methanol–ether); $[\alpha]_D^{18}$ + 6·9° (10 min.), → + 10·4°

equil. (conc. 2·3 in water). Found: C, 35·9; H, 7·4 per cent; calc. for $C_8H_{14}O_4NCl$: C, 36·1; H, 7·1 per cent. 'Amino-sugar X' was crystallized from a water–methanol–acetone mixture.

A comparison of the electrophoretic mobilities of the *N*-acetyl derivatives of 'pneumosamine' (M_G 0·40), 2-amino-2,6-dideoxy-L-galactose (M_G 0·29) and 2-amino-2,6-dideoxy-D-glucose (M_G 0·0) in borate buffer indicated that the hydroxyl groups on $C_{(3)}$ and $C_{(4)}$ were *cis* related, since vicinal *trans* hydroxyl groups (as in 2-acetamido-2,6-dideoxy-D-glucose) do not complex with borate[5,6]. Such *cis*-related hydroxyl groups are present in sugars having the *allo*-, *altro*-, *galacto*- and *talo*- configurations. 'Pneumosamine' and 2-amino-2,6-dideoxy-L- or -D-galactose had different paper and ion-exchange chromatographic properties and optical rotations. The best method of distinguishing between the remaining three configurations seemed to be by deamination, despite the complexity of the reaction[7,8]. A chromatographically homogeneous product was obtained from 'pneumosamine' by deamination under rigorously controlled conditions. This product migrated the same distance as 6-deoxy-L-galactose and separated on the same chromatogram from 6-deoxyallose, 6-deoxyaltrose, 6-deoxytalose and 6-deoxymannose. The deamination therefore indicated that 'pneumosamine' was probably 2-amino-2,6-dideoxytalose, and that deamination proceeded with inversion at $C_{(2)}$. An analogy may be drawn with the deamination of 2-amino-2-deoxy-D-mannose (axial amino group), which proceeds with Walden inversion at $C_{(2)}$ (refs. 9 and 10). Deamination of 2-amino-2-deoxy-D-glucose (equatorial amino group) proceeds with ring contraction and the product is an anhydro sugar[9,11]. Possibly the difference in energy between the two chair conformations of 2-amino-2,6-dideoxytalose is sufficient, under the conditions of deamination, for the conformation with an axial amino group to predominate.

'Amino-sugar X' and its *N*-acetyl derivative were found to be indistinguishable from 2-amino-2,6-dideoxy-L-galactose (L-fucosamine) and 2-acetamido-2,6-dideoxy-L-galactose by paper and ion-exchange chromatography and by electrophoresis. The infra-red spectra of an equilibrium mixture of the isolated sugar and authentic L-fucosamine were almost completely superimposable. *N*-Acetylation of a crude sample of 'amino-sugar X', followed by separation on Whatman No. 3 filter paper, gave a crystallizable product of melting point 195–198° (uncorr.), undepressed on admixture with authentic *N*-acetyl-L-fucosamine, $[\alpha]_D^{20} - 79°$ equil. (conc. 0·17 in water). The infra-red spectra of an equilibrium mixture of the *N*-acetylated product and of authentic *N*-acetyl-L-fucosamine were also identical. The amino-sugar was assigned to the L-series on the basis of optical rotation data. Furthermore, it was possible to epimerize[12] '*N*-acetylpneumosamine' to an equilibrium mixture containing a product chromatographically indistinguishable from either authentic *N*-acetylfucosamine or '*N*-acetylamino-sugar X'. This affords additional evidence that 'pneumosamine' and 'amino-sugar X' are epimeric at $C_{(2)}$.

Neither 2-amino-2,6-dideoxy-L-galactose (L-fucosamine) nor 2-amino-2,6-dideoxytalose has been previously found in Nature, and the latter sugar was hitherto unknown. Its synthesis is at present being undertaken in our laboratories. The discovery of these amino-sugars in the amino-sugar – rich *Pneumococcus* species should stimulate much work, both chemical and immunological, in order to improve our understanding of the specificity of immunological reactions.

We are indebted to Profs. R. Kuhn and T. Reichstein, Drs. D. A. L. Davies and C. J. Morel for providing gifts of amino-sugars and 6-deoxyhexoses. We are also indebted to Prof. M. Heidelberger, who supplied the Type V polysaccharide. Two of us (M. J. H. and J. M. W.) thank the University of Birmingham for research grants.

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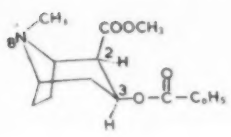
Specification of Asymmetric Nitrogen Atom. Application of the Cahn–Ingold–Prelog Nomenclature to some Tertiary Amines and Quaternary Ammonium Salts

Though the Cahn–Ingold–Prelog nomenclature[1] is quite generally valid for specifying asymmetric systems, and was proposed by its authors for the unambiguous description of both organic and inorganic systems, little application is to be found in the literature[2] so far relating to the characterization of nitrogen atoms of known configuration by this convention.

The specification of an asymmetric nitrogen atom follows from the general definition given by Cahn, Ingold and Prelog. Accordingly, in the case of a tertiary nitrogen atom, the three substituents attached to it should be regarded as the *a*, *b* and *c* groups, whereas the fourth substituent (*d*) of zero ordinal number is the unshared electron pair. Existence of tertiary amines of stable configuration makes it necessary to accept the orientation of the unshared electron pair of the nitrogen atom; this fact can be deduced both from quantum mechanical calculations[3] and evidence obtained in a synthetical chemical way[4].

Compounds of known configuration and containing an asymmetric tertiary nitrogen atom are known among the tropane alkaloids[5]. Fodor *et al.*[6] showed that in the case of the tertiary tropane derivatives investigated, the substituents attached to the nitrogen and not contained within the ring had N-α-configurations. Summarizing the results of the investigations



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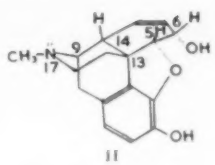

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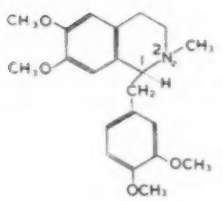
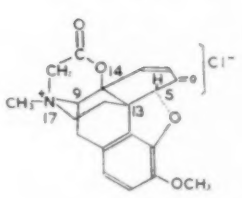


III



IV

of Hardegger and Ott[7] relating to the absolute configuration of the C_2 and C_3 carbon atoms of (−)-cocaine, and those of Kovács, Fodor and Halmos[8] as regards the absolute configuration of the asymmetric nitrogen atom of the skeleton, natural (−)-cocaine (I) may be described as having a $2R : 3S : 8R$ configuration.

In the course of earlier research work we[9] reported the configurational stability of the tertiary nitrogen atom of the morphine skeleton. Assuming an equatorial position of the N-methyl group (which is also supported by our recent investigations[10]) the asymmetric tertiary nitrogen atom will be of *S*-configuration. Consequently, morphine (II) should be regarded as having $5R : 6S : 9R : 13S : 14R : 17S$ configuration[11].

It is known from the work of Corrodi and Hardegger[12] that the C_1 atom of (+)-laudanosine (III) has the *S*-configuration. Since Knabe[13] ascribes an equatorial steric position for the C_1 substituent of laudanosine and an axial position for the N-methyl group, it follows that the nitrogen is of *R*-configuration.

The assignment of asymmetric quaternary ammonium salts is obvious. It follows that 14-hydroxycodeinone lactone hydrochloride[10] (IV) may be characterized by the configuration $5R : 9R : 13S : 14R : 17S$.

Application of the Cahn–Ingold–Prelog nomenclature, in the sense shown here, to tertiary amines having nitrogen atoms of known configuration and of configurational stability, as well as to quaternary ammonium salts, permits a more complete and unequivocal description of the compounds.

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BIOCHEMISTRY

Non-Enzymic Decarboxylation of Methionine by Ferrous Ion

In work on the precursors of the volatile sulphur components of vegetable flavours and odours, a non-enzymic oxidative decarboxylation of methionine in the presence of Fe^{2+} was observed. The final reaction mixture had a very pronounced odour. Unlike other well-known Fe^{2+} oxidations, there was no need for added hydrogen peroxide[1,2] or ascorbic acid[3,4]. The addition of a metal chelating agent such as ethylenediamine tetraacetate (EDTA) or citrate was very stimulatory. Table 1 shows the absolute requirement for Fe^{2+}. Only Fe^{2+} was able to carry out this decarboxylation. Mg^{2+}, Mn^{2+}, Ca^{2+}, Co^{2+}, Ni^{2+}, Zn^{2+}, Cu^{2+} and Al^{3+} were completely ineffective. Fe^{3+} was 1 per cent as effective as Fe^{2+}.

Table 1. Requirements for Methionine Decarboxylation

Reaction system*	mμc. ^{14}C as CO_2
Complete	58·8
Minus Fe^{2+}	0
Minus EDTA	13·1
Complete, 0·5 μmole Fe^{3+} instead of 5 μmoles	7·2

* Complete reaction system contained 2 μmoles 1-^{14}C DL-methionine containing 0·5 μc., 5 μmoles ferrous chloride, 5 μmoles EDTA, 100 μmoles phosphate buffer pH 7, and distilled water to a final volume of 2 ml. This solution was in the main chamber of a Warburg vessel. In the centre well was 0·2 ml. 20 per cent potassium hydroxide and in the sidearm 0·3 ml. 5 *N* sulphuric acid. The reaction was incubated 90 min. at 30° C., the acid tipped and the potassium hydroxide collected 10 min. later. The absorbed carbon dioxide was counted as a gas in an ionization-type counter.

The participation of free hydrogen peroxide did not seem to be indicated since the addition of crystalline catalase only inhibited the reaction by 19 per cent. The reaction was found to be aerobic in nature. In a nitrogen atmosphere the amount of carbon dioxide produced from the methionine carboxyl group was decreased by 88 per cent. The residual activity remaining in the nitrogen-flushed reaction mixture was probably due to the small amount of dissolved oxygen which had not been displaced by the method of flushing used.

The addition of ascorbic acid to the reaction mixture gave a large increase in the amount of carbon dioxide released. In the presence of ascorbic acid, Fe^{3+} was as effective as Fe^{2+}. EDTA was required for the stimulatory effect of ascorbic acid to be demonstrated. These results are summarized in Table 2.

Table 2. Ascorbate Effect on Decarboxylation

Reaction system*	Total counts as $Ba^{14}CO_3$
Complete	23,990
Minus EDTA	7,255
Plus ascorbate	42,145
Plus ascorbate, minus EDTA	8,834
Complete, Fe^{3+} for Fe^{2+}	332
" " " " plus ascorbate	42,385
" " " " " " minus EDTA	8,804

* Reaction system and conditions same as in Table 1. 5 μmoles ferric chloride and 10 μmoles ascorbic acid are added where indicated. Absorbed $^{14}CO_2$ was precipitated, plated and counted as $Ba^{14}CO_3$ by a thin-window Geiger–Müller-type counter.

The question whether the ascorbic acid effect is due to maintenance of Fe^{2+} concentration or to a different mechanism is left open. Preliminary work indicates that the reaction is not of an important general nature as regards amino-acids. 1-^{14}C DL-alanine was decarboxylated to only 1 per cent and 1-^{14}C DL-methionine sulphoxide to only 6 per cent that of an equivalent amount of methionine under the same conditions.

A large-scale reaction was carried out in order to isolate the reaction product. 250 μmoles phosphate buffer *p*H 7, 200 μmoles ferrous chloride, 200 μmoles EDTA *p*H 7, and 500 μmoles DL-methionine in a final volume of 9·5 ml. were incubated for 90 min. at room temperature with constant shaking. The reaction mixture was then acidified with 3 ml. 10 per cent trichloracetic acid, and 10 ml. 0·01 *M* 2,4-dinitrophenylhydrazine in 2 *N* hydrochloric acid were added. After cooling at 10° C. overnight, the precipitate which formed was removed by filtration and after drying over calcium chloride was recrystallized from ethanol–water. An infra-red spectrum of a potassium bromide pellet of the recrystallized material was obtained from 3 to 15μ. This spectrum was identical with that of a known sample of the 2,4-dinitrophenylhydrazone of methional. It would appear that the decarboxylation is also accompanied by some deamination to yield the corresponding aldehyde.

I wish to thank Mrs. Edith L. Gong and Mr. Glen F. Bailey for the infra-red analyses.

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Chromatography of the Proteins from Wheat Flour soluble in Acetic Acid

THE heterogeneity of the gluten fraction of wheat flour has been well established by the moving boundary[1,2], starch-gel[3] and filter paper curtain[5] methods of electrophoresis. The last-mentioned technique has also been used for fractionation purposes. The chromatographic separation of gluten into four major electrophoretically distinguishable components by stepwise elution from carboxymethyl-cellulose has also been reported briefly[1,6]. This communication reports the resolution of the acetic-acid-soluble fraction of flour into six components by gradient elution from carboxymethyl-cellulose.

Flour, milled from Gabo wheat to approximately 70 per cent extraction on a Buhler laboratory mill, was extracted successively with water-saturated *n*-butanol (1 treatment), 0·01 *M* sodium pyrophosphate (*p*H 7·0; 4 treatments) and 0·05 *N* acetic acid (*p*H approximately 3·5; 4 treatments) in accordance with the procedure described by Coates and Simmonds[7]. Under these conditions 18–20 per cent of the nitrogen was soluble in the sodium pyrophosphate, 55–60 per cent was soluble in the acetic acid and the remainder could be extracted with 0·1 *N* sodium hydroxide. The butanol extract contained only 0·5–2·0 per cent of the total nitrogen.

The acetic acid extract, containing 50–100 mgm. of protein nitrogen in 100 ml., was dialysed against 0·005 *M* sodium acetate buffer *p*H 4·1, and loaded on to a carboxymethyl-cellulose column (1·5 × 15 cm.) previously equilibrated with the same buffer. Under these conditions most of the protein was bound to the carboxymethyl-cellulose, but a small amount, designated fraction α, passed unretarded through the column. In order to remove completely the remainder of fraction α, the column was washed with a further 30 ml. of the 0·005 *M* sodium acetate buffer, followed by 300 ml. of the same buffer containing 1·0 mole of dimethyl-formamide per litre (final *p*H 4·1). Three protein components (peaks β, γ and δ in Fig. 1) were then eluted using a sodium chloride gradient running from 0 to 1 *M*, total volume 1 l., the molar concentrations of sodium acetate and dimethyl-formamide being maintained at 0·005 and 1·0 respectively. Two additional components (peaks ε and θ in Fig. 1) could be eluted by running a further gradient from acetate buffer 0·005 *M* in sodium acetate (*p*H 4·1) to a phosphate solution *p*H 12, containing 0·005 mole of trisodium phosphate per litre, both solutions being 1·0 *M* with respect to sodium chloride and dimethyl-formamide: the total volume of this gradient was also one litre. Any protein still adhering to the column was then removed with 0·1 *M* sodium hydroxide (peak ω in Fig. 1): this peak is not considered to represent a definite protein component and has been included in the elution diagram to indicate the amount of protein not recovered from the column by the two gradients employed. Fig. 1 shows the sequence of the elution pattern and the *p*H of the effluent at each stage, together with an estimate of the protein distribution between peaks, determined by the method of Lowry, Rosebrough, Farr and Randall[8].

Using this procedure, a series of acetic acid extracts from 12 Australian flours was examined, 100 mgm. of protein nitrogen being loaded in each case. This allowed a resolution of the main protein components similar to that shown in Fig. 1. However, the solubilities of these were such that material in the peak tubes of components β, δ, ε and θ was precipitated on elution from the column. This precipitate was soluble in 0·05 *M* acetic acid. The only obvious difference in the elution patterns obtained was a variation in the size of the δ peak, which was not even detected in several cases.

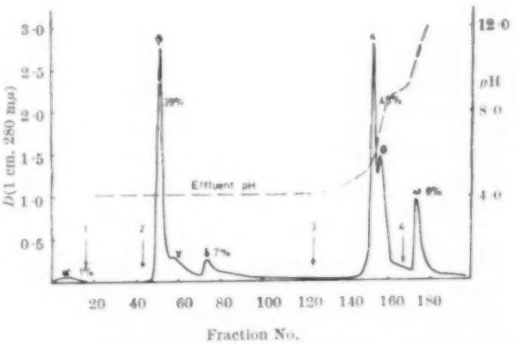

Fig. 1. Elution of flour protein components from a carboxymethyl-cellulose column. Loading: 100 mgm. of protein nitrogen derived from the 0·05 *M* acetic acid soluble fraction of Gabo flour. Column: 1·5 cm. × 15 cm., equilibrated to *p*H 4·1 with 0·005 *M* sodium acetate buffer. Size of fractions: 12 ml. Eluting solvents changed as follows: Arrow No. 1, 0·005 *M* sodium acetate containing 1·0 *M* dimethyl formamide; *p*H 4·1. Arrow No. 2, gradient started to 0·005 *M* sodium acetate containing 1·0 *M* dimethyl formamide and 1·0 *M* sodium chloride; *p*H 4·1. Arrow No. 3, gradient started from previous final solvent to 0·005 *M* trisodium phosphate containing 1·0 *M* dimethyl formamide and 1·0 *M* sodium chloride; *p*H 12·0. Arrow No. 4, 0·1 *N* sodium hydroxide

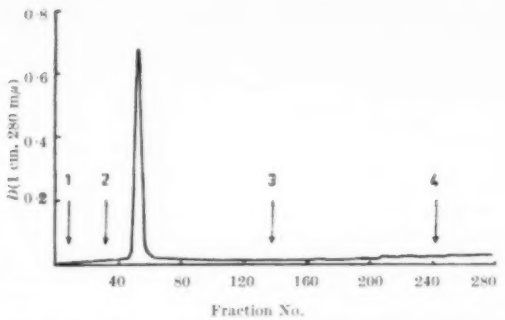

Fig. 2. Rechromatography of fraction β (Gabo flour) on carboxymethyl-cellulose. Loading: 15 mgm. of protein nitrogen. Column: 1·5 cm. × 15 cm., equilibrated to *p*H 4·1 with 0·005 *M* sodium acetate buffer. Size of fractions: 10 ml. Order of change in eluting solvents as indicated in Fig. 1

Rechromatography of fraction β on carboxymethyl-cellulose gave a symmetrical elution peak as shown in Fig. 2, but there is no certainty that this or any of the peaks would behave as a single homogeneous protein when subjected to other methods of fractionation. In fact, Elton and Ewart[4] have demonstrated by starch-gel electrophoresis the presence of at least eight components in acetic acid extracts of glutens obtained by hand-washing flours with distilled water. It is possible that some of these components correspond to traces of albumin and globulin fractions[9], which would have been removed during our preliminary treatment of the flour with sodium pyrophosphate.

Dimethyl formamide, which has been used by Vercouteren and Lontie[10] to disperse gluten, was added to the buffer to prevent precipitation of protein from solutions of ionic strength greater than 0·04. In this case it has allowed the successful elution of components from the column using salt and mild *p*H gradients. There is evidence that the reaction between hydrogen bond - breaking agents and gluten is reversible[11,12].

Full details of this work will be submitted for publication in due course.

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Optical Rotatory Dispersion of the Thrombin-induced Conversion of Fibrinogen to Fibrin Monomer

Considerable evidence has now accumulated suggesting that the thrombin-induced conversion of fibrinogen to fibrin is a reversible triphasic reaction which may be represented thus[1]:

$$\begin{array}{lll} \text{Step 1} & \text{Proteolysis} & F \overset{T}{\rightleftharpoons} f + P \\ \text{Step 2} & \text{Polymerization} & nf \rightleftharpoons f_n \\ \text{Step 3} & \text{Clotting} & mf_n \rightleftharpoons \text{fibrin} \end{array}$$

where F is fibrinogen, T is thrombin, f is fibrin monomer, P represents non-protein nitrogenous material consisting primarily of two acidic peptides of molecular weights 1,900 and 2,400, and f_n represents intermediate polymers where n and m are variable numbers.

Hydrogen bonding has been implicated in this reaction scheme in two important aspects. First, the polymerization of f to intermediate polymers (step 2) has been shown to proceed through the formation of intermolecular hydrogen bonds between tyrosyl donors and histidyl acceptors[2]. Secondly, it has been suggested that either the donor or acceptor groups are unavailable in the intact fibrinogen molecule because they are hydrogen-bonded to the highly acidic groups of the two peptides released in step 1; they become available only when the hydrogen bonds in which they are participants are broken[1]. If such hydrogen bonds exist in the native fibrinogen molecule, they should be playing a significant part in stabilizing that portion of the molecule which is regularly folded; conversely, the rupture of these bonds should decrease the stability of the helical portions of the molecule. In order to observe whether configurational changes of this type accompany the thrombin-catalysed proteolysis of fibrinogen, measurements of the optical rotatory dispersion of this system were undertaken. To facilitate studies of step 1 free of steps 2 and 3, use was made of the finding that step 1 will occur in 1 *M* sodium bromide at *p*H 5·3 without the subsequent polymerization of fibrin monomer[3].

The bovine fibrinogen used ('Pentex' lot 20*F* 14) was refractionated by Laki's procedure[4]; a product which was 95 per cent clottable, as assayed by the method of Laki[4], was obtained. A purified citrate-activated thrombin preparation kindly supplied by Dr. W. H. Seegers was used. This product, received and stored in aqueous solution, had an activity of 4,000 tosylarginine methyl ester units/mgm. The optical rotatory measurements were carried out on a Rudolph model 260 automatic recording spectropolarimeter using a xenon compact arc-lamp as the light source. Kinetic measurements were made at 400 and 589 mμ. At the beginning and end of each reaction a complete optical rotatory dispersion curve was run; in these cases the results were evaluated in accordance with the method of Yang and Doty[5], by plotting the product of the specific rotation and squared wave-length versus specific rotation.

Column 2 of Table 1 lists the variation of optical rotation with wave-length for a 2·5 per cent fibrinogen solution in 1 *M* sodium bromide at *p*H 5·3 (0 time curve). It is to be noted that $[\alpha]_D$ is $-53°$ and λ_0, evaluated from the slope of the plot of $\lambda^2[\alpha]$ versus $[\alpha]$, is 227 mμ; these values are to be compared with an $[\alpha]_D$ of $-48·6°$ and a λ_0 value of 256 mμ, obtained

Table 1. Optical Rotatory Dispersion Results for Fibrinogen and Fibrin Monomer

Wavelength, λ (Å.)	$-[\alpha]$ for fibrinogen (2·63 per cent)	$-[\alpha]$ for fibrin monomer (2·55 per cent) formed from fibrinogen of column 2	$-[\alpha]$ for fibrin monomer (3·2 per cent) formed from fibrin
5890	53	51	53
5500	65	63	62
5000	84	80	81
4500	103	99	100
4250	122	118	116
4000	141	141	141
3800	171	165	162
3700	—	—	181
3600	201	200	197
3500	224	223	216
3400	257	247	—
3300	285	286	—
3200	327	325	—
λ_0 (mμ)	226·9	228·0	225·8

by Yang and Doty for fibrinogen in 0·3 *M* potassium chloride at *p*H 6·3[5]. The increase in levorotation and decrease in dispersion constant in the bromide solvent are consistent with the idea that this medium is a denaturing one[6] and that it prevents steps 2 and 3 from setting in because of its ability to break hydrogen bonds.

At zero time, thrombin was added to the fibrinogen solution in the polarimeter cell such that its final concentration was 100 units/ml. The cell contents were mixed and the rotations at 400 and 589 mμ were followed for 20 hr. (half-time about 3 hr. at 25° C.[7]); these were not found to vary significantly, suggesting that the kinetics of the reaction are not reflected in optical rotatory changes. In this respect, this reaction differs from other examples of limited proteolysis reactions, notably the zymogenic activation reactions of chymotrypsinogen, trypsinogen and pepsinogen, all of which are accompanied by easily measurable changes in optical rotation[8]. At the completion of the reaction the solution was exhaustively dialysed against 1 *M* sodium bromide at *p*H 5·3 in order to remove the liberated peptides and an optical rotatory dispersion curve was carried out on the remaining fibrin monomer (see column 3 of Table 1). As can be seen, none of the rotations for the fibrin monomer differs significantly from the values obtained for fibrinogen alone; furthermore the calculated λ_0 values agree within experimental error, suggesting that the degree of ordered configuration in the two molecules is the same. As a further check that the dispersion results of column 3 represent the values for fibrin monomer and not those of monomer plus adsorbed contaminants, purified fibrin monomer was obtained by dissolving fibrin in 1 *M* sodium bromide at *p*H 5·3 (that is, by reversing steps 2 and 3 in the bromide solvent[9]). The optical rotatory dispersion of a 3·2 per cent solution of this material is presented in the final column, from which it is seen that essentially identical optical rotatory results are obtained for fibrin monomer prepared by either the forward or backward reactions.

The virtual identity in optical rotatory properties of native fibrinogen and fibrin monomer suggests that the two peptides liberated in the proteolysis reaction must be essentially devoid of helix; otherwise their removal would have resulted in different dispersion constants for the two solutions. This finding is consistent with the preliminary amino-acid analysis of the two peptides[9], which reveals in each the presence of a number of dicarboxylic amino-acid residues as well as two prolines; both the high density of negative charge and presence of two imino-acids would tend to favour a randomly oriented configuration. Finally, the lack of optical rotatory change associated with the kinetic process implies that the donor or acceptor groups liberated in step 1 appear, more likely as the result of an unmasking process, that is, a removal of a steric impediment exerted by the peptides rather than by rupture of side-chain hydrogen bonds which would be expected to have been reflected in optical rotatory changes.

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The Problem of 'Methæmocyanin'

It was thought that, analogously to the iron in hæmoglobin, the copper of hæmocyanin remained in the cuprous (Cu^+) state when the pigment took up oxygen[1]. This was questioned[2] because the characteristic blue colour of the cupric ion (Cu^{++}) appeared when oxyhæmocyanin was formed, as well as on other grounds. It has since been shown[3], using the hæmocyanin of *Busycon*, *Loligo*, *Homarus* and *Limulus*, that in fact half the copper becomes Cu^{++} and the rest remains Cu^+. There was occasion to confirm this on the bloods of *Helix* and *Maia*, in the course of other work[4]. Klotz and Klotz[3] showed that the oxygenation probably depends on the co-operation of the two ions. A number of further differences in properties between hæmocyanin and hæmoglobin also were explained by their important discovery.

There still remains some obscurity, however, concerning 'methæmocyanin', which is prepared, like methæmoglobin, by the action of strong oxidizing agents on the pigment[5]. It is not clear why methæmocyanin should still be able to take up oxygen reversibly, with a colour change essentially similar to that of hæmocyanin itself. Since half the copper is converted to Cu^{++} even by atmospheric oxygen it appears to be more easily oxidized than the iron of hæmoglobin. Yet the latter is entirely converted to ferric in methæmoglobin and can no longer take up oxygen reversibly. It has been confirmed, using *Maia* blood, that hæmocyanin does retain this ability for reversible oxygenation–deoxygenation, with colour

change, in the presence of such strong oxidizing agents as potassium ferricyanide and potassium permanganate. If the oxidizing agent is added to two samples of deoxyhæmocyanin and one is then shaken with air, the change in colour is readily apparent by comparison with the control.

It is also clear that oxidizing agents do not increase the amount of blue Cu^{++} ion present in oxyhæmocyanin or produce any in deoxyhæmocyanin. There is no increase in extinction of light of 570 mμ wavelength when *Maia* blood is saturated with potassium chlorate or treated with other colourless oxidizing agents, such as potassium iodate and hydrogen peroxide (neutralized with sodium peroxide). This may be confirmed also using potassium ferricyanide which absorbs very little light at that wave-length. The evidence is that the copper is quite 'unavailable' to these and also to other agents, though available to atmospheric oxygen. For example, sodium diethyldithio-carbamide, a sensitive, specific reagent for copper ions, gives no colour reaction with native *Maia* blood, though this appears sharply at a certain stage of denaturation, for example, by heating to 60° C. This applies equally to the reaction with 2 : 2′-diquinolyl, a specific colour reaction of the Cu^{+} ion[2], alone.

If an excess of such oxidizing agents as potassium ferricyanide and potassium permanganate is added to *Maia* blood, which is then denatured to 'reveal' the copper ions, it is found that all are now in the Cu^{++} state. Oxidation of free Cu^{+} to Cu^{++} is presumable instantaneous, as shown also by adding the oxidizing agent after denaturation in the presence of diquinolyl, in a suitable solvent (glacial acetic acid is most convenient since it also denatures the protein, and redissolves it on warming). Using potassium chlorate as oxidizing agent, some of the Cu^{+} survives for a time after release by denaturation and the pink colour with diquinolyl fades slowly.

A further feature of interest is that the Cu^{++} of denatured hæmocyanin oxidized by potassium permanganate returns spontaneously to Cu^{+}, slowly at room temperature and more rapidly on warming. Preparations from oxyhæmocyanin give a final yield of Cu^{+} about half the amount obtained from deoxyhæmocyanin preparations, indicating that ions initially in the Cu^{++} state remain so. However, on repeated oxidation with potassium permanganate, followed by spontaneous reduction, the amount of Cu^{+} progressively increases. Reducing agents still readily reduce the Cu^{++} to Cu^{+}. Potassium dichromate shows the same behaviour as potassium permanganate; but ferricyanide, chlorate and hydrogen peroxide, in excess, appear to oxidize irreversibly. Using minimal amounts of hydrogen peroxide the ion can be reduced once more simply by exposure to low oxygen tension, over alkaline pyrogallol, so that denatured hæmocyanin might still be a reversible oxygen carrier, under appropriate conditions.

It is interesting that potassium permanganate should have been used[3] to prepare 'methæmocyanin', rather than ferricyanide, which is used for methæmoglobin and seems more capable of effecting irreversible change. The reason given was that ferricyanide does not release oxygen from oxyhæmocyanin, though there seems no good evidence that permanganate does. In any event, however, neither seems to affect the copper of the native pigment. This seems much more sensitive to reducing than to oxidizing agents therefore.

Some of these properties of hæmocyanin are mimicked by synthetic copper proteins, a further indication that there is no special prosthetic group in hæmocyanin. When ten volumes of 1 per cent egg albumen solution are added to one of 0·1 per cent copper sulphate, a copper protein is formed, the colour of the Cu^{++} ion becoming intensified. Moreover, on adding diquinolyl in *iso*amyl alcohol a positive reaction for the Cu^{+} ion gradually develops. The protein is near its isoelectric point and denatures spontaneously. At a more alkaline *p*H it can be denatured by heat without release of the Cu^{+} ion which, however, appears on acidification. The albumen appears to bind and to reduce some of the copper. It is even capable of reducing Cu^{++} added after it has been denatured with acetic acid. The Cu^{+} of the denatured copper protein, in acetic, is oxidized by potassium permanganate and spontaneously reduces on standing. This is also true of the copper protein of *Lithobius*[4], in the reduced, denatured state.

Thus it seems that proteins commonly have the power to reduce Cu^{++} to Cu^{+} and to do so repeatedly following reoxidation, whether it is bound in non-ionic form to the native protein or associated as an ion, after denaturation. In native hæmocyanin, at least, the $Cu^{+} \rightleftharpoons Cu^{++}$ change is associated with reversible oxygenation, and this process is not affected by strong chemical oxidizing agents. It would seem reasonable to keep the term 'methæmocyanin' in abeyance until there is evidence of a definite compound similar to methæmoglobin.

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Activation of Cockroach Acetylcholinesterase by Water-miscible Organic Solvents

It is common practice to treat insects with poisons dissolved in acetone or dioxane. Also, water-insoluble anti-cholinesterases are dissolved in organic solvents to determine their inhibition of acetylcholinesterase *in vitro*. While studying functional properties of acetylcholinesterase of the American cockroach[1], evidence was obtained that inclusion of acetone or some alcohols in a Warburg reaction mixture resulted in greater hydrolysis of acetylcholine. These results are given in Table 1, where 0·1 ml. of the organic solvents was included in a Warburg reaction mixture of salts, buffer, substrate and tissue homogenate, final volume, 2·7 ml. The increase in hydrolysis of acetylcholine was most striking in the presence of *n*-propanol and *n*-butanol. Further work showed that the optimal concentration of *n*-butanol for maximal hydrolysis of acetylcholine was 0·05 ml. in 2·7 ml. of reaction mixture. Acetone differed in this respect and optimal activity was obtained at 0·25 ml. of acetone in 2·7 ml. of reaction mixture.

Bovine purified erythrocyte and homogenates of housefly thoracic ganglia and mouse brain were used as sources of acetylcholinesterase for a comparison

Table 1. Effect of Various Solvents* on the Rate of Hydrolysis of Acetylcholine by Acetylcholinesterase from Cockroach Ganglia

Solvent	Average b_{20}†	Activation ratio $\frac{\text{Solvent } b_{20}}{\text{Control } b_{20}}$
iso-Octane	48·0	1·05
Dioxane	48·1	1·05
Ethyl alcohol	50·7	1·1
Acetone	71·5	1·56
iso-Butanol	106·0	2·31
iso-Amyl alcohol	124·5	2·72
iso-Propanol	132·1	2·89
n-Propanol	142·7	3·12
n-Butanol	180·8	3·95
Control	45·7 ± 2·1	

* 0·1 ml. acetone in 2·7 ml. of reaction mixture.
† b_{20} refers to the amount of carbon dioxide evolved in 30 min. after correction for non-enzymatic hydrolysis.

with homogenates of the thoracic nerve cord of the cockroach in the presence of solvents. The results given in Table 2 for acetone show that only the acetylcholinesterase of the cockroach was activated. The acetylcholinesterase from the other sources was inhibited when compared with controls in which acetone was omitted. This result shows a striking difference in the acetylcholinesterase of the cockroach-hydrolysing acetylcholine.

Table 2. Effect of Acetone* on Acetylcholinesterases from Various Sources

Source	Average b_{20}† control	Average b_{20} with acetone	Activation ratio $\frac{\text{Acetone } b_{20}}{\text{Control } b_{20}}$
Cockroach thoracic ganglia	48·2	83·1	1·72
Housefly thoracic ganglia	37·4	31·3	—
Mouse brain	140·4	115·8	—
Bovine purified erythrocyte	225·4	183·0	—

* 0·1 ml. acetone in 2·7 ml. of reaction mixture.
† b_{20} refers to the amount of carbon dioxide evolved in 30 min. after correction for non-enzymatic hydrolysis.

As the above results were determined with homogenates, experiments were then carried out with acetone and butanol powders of the nervous tissue of the cockroach. Manometric determinations of the reconstituted acetylcholinesterase showed that the activation effect of *n*-butanol and acetone was not eliminated when these solvents were included in the reaction mixture. Furthermore, these results showed that the effect found with homogenates was not due to a liberation of more acetylcholinesterase from tissue fragments or to an inhibiting factor. The use of differential centrifugation and various substrates gave positive evidence that only one enzyme hydrolysed acetylcholine. The enzyme appears to be particulate, and when solubilized by use of sodium cholate similar activation was found with *n*-butanol.

Results obtained on the kinetics of hydrolysis of acetylcholine and other substrates in the presence of *n*-butanol and anticholinesterases gave evidence of the possible mechanism of activation. This appears to be an effect of the solvents on the active sites of the acetylcholinesterase of the cockroach. If so, a specific property has been found for the acetylcholinesterase of the nervous tissue of the cockroach. Details of these results will be published elsewhere.

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O-Demethylation as a Biosynthetic Pattern in the Formation of Opium Alkaloids

Comparative rates of incorporation of carbon dioxide labelled with carbon-14 led to the proposal[1] that, in *Papaver somniferum*, thebaine is the first octahydrophenanthrene alkaloid formed, and is converted by successive O-demethylations to codeine and finally to morphine. Although this sequence seemed best to explain the labelling ratio among these three alkaloids, conclusive proof was lacking. The results described here, considered with the previous data[1], constitute proof of this interrelationship.

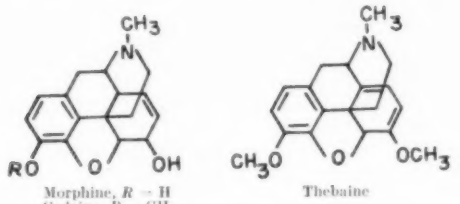
Three plants of *P. somniferum*, each 2½ months old, were root-fed, respectively, labelled morphine, codeine and thebaine, which were obtained from a three-day biosynthesis with labelled carbon dioxide[1]. The alkaloids were absorbed from a weak potassium dihydrogen phosphate solution over the course of 42 hr., and the plants then were frozen immediately and the alkaloids isolated as previously described[1]. The results are given in Table 1.

Table 1. Carbon-14 Labelled Alkaloid Feeding Experiments

Plant No.	Alkaloid fed	Alkaloid isolated	Amount (mgm.)	Total activity (d.p.m.)	Specific activity (d.p.m./μmole)
1	Morphine	—	0·089 absorbed	621,000	2,000,000
		Morphine	1·53	337,000	62,800
		Codeine	0·088	none	—
		Thebaine	0·021	none	—
2	Codeine	—	0·12 absorbed	3,500,000	8,650,000
		Morphine	1·03	355,000	98,300
		Codeine	0·28	402,000	425,000
		Thebaine	0·042	none	—
3	Thebaine	—	0·04 absorbed	2,280,000	18,000,000
		Morphine	0·87	77,100	19,200
		Codeine	0·19	66,000	105,000
		Thebaine	0·026	29,900	321,000

Of the three alkaloids isolated from the morphine-fed plant, only morphine was radioactive; of those from the codeine-fed plant, only morphine and codeine were active; while from the thebaine-fed plant all three alkaloids were active. Since the alkaloids fed were from a biosynthesis with labelled carbon dioxide, they would be labelled both in the methyl groups and ring skeleton[1]. Hence it was necessary to demethylate and check ring skeleton activity in the isolated alkaloids in order to establish that incorporation of radioactivity was not simply due to transmethylation. The necessary degradations[1] were performed on thebaine which was fed to plant 3 and on the morphine and codeine isolated from that plant after 42 hr. It was found that the ratio of methyl group to ring skeleton activity was approximately the same in the thebaine as in the morphine and codeine isolated. Therefore, incorporation of radioactivity was not due to transmethylation, and the entire ring skeleton was converted to codeine and thence to morphine in accordance with the proposed scheme[1].

A comparison of the specific activities of the codeine and thebaine which were fed with the specific activities of the same alkaloids isolated at the end of 42 hr. shows that the final values are much lower than one would expect on the basis of pool dilution alone. This indicates a relatively rapid synthesis and conversion of the alkaloids, especially of thebaine, and a high percentage incorporation of specific activity would not be expected. Somewhat more meaningful



Morphine, $R = H$
Codeine, $R = CH_3$

Thebaine

in this case is the incorporation of total activity. Based on ring skeleton activities derived from the above-mentioned degradations, a 13 per cent incorporation was achieved from codeine to morphine in plant 2, while the incorporation from thebaine to morphine and codeine in plant 3 was 7·5 and 5·0 per cent, respectively. The values listed in Table 1 for the amount of alkaloid absorbed are based on loss of activity from the feeding solution. Experiments now under way show that a rapid adsorption or absorption of the alkaloids by the root hairs occurs, but that the further translocation is relatively slow. After the 42-hr. biosyntheses reported here, these root hairs had been removed and were not included in the total plant analysis. Therefore, the values for the percentage incorporation of total activity given above are undoubtedly minimal.

The proved conversion of thebaine to codeine and codeine to morphine clearly establishes O-demethylation as a metabolic pathway. This is in contrast to the commonly held concept[2] that the O-methylated alkaloids are metabolic end-products. Because of the relatively rapid synthesis and interconversion of alkaloids which has been found in this and the previous work[1], such demethylations could be a significant part of the total plant metabolism and perhaps provide one answer to the century-old problem of alkaloid function.

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Phenolase and Pectic Enzyme Activity in the Chocolate Spot Disease of Beans

The chocolate spot disease of beans (*Vicia faba* L.) caused by *Botrytis fabae* Sard. is so named because an early result of infection by the fungus is a small brown lesion on leaf or stem. In the course of studying the factors controlling the development of these lesions, it was found that the latent phenolase of bean leaves could be activated by certain pectic substances and by a soluble cellulose derivative in a way similar to that described by Kenten[1] for anionic wetting agents. The result of phenolase action, with the naturally occurring leaf phenols as substrate, is an intense brown coloration.

Kenten[1,2] showed that aqueous extracts of bean leaves had very little phenolase activity, measured by oxygen uptake or by coloured end-products, unless extracts were first exposed to acid or alkaline conditions, precipitated by ammonium sulphate, or incubated with certain anionic wetting agents. In the present experiments, mixtures of dialysed leaf extracts, citrate/phosphate buffer and activators were incubated for appropriate periods. They were then added to catechol or dihydroxyphenylalanine (DOPA) at *p*H 7·0. Phenolase activity was measured in an EEL colorimeter with green filter 623. Kenten's results were confirmed with sodium dioctyl sulphosuccinate as the activating agent: the optimum *p*H for activation was 5·5, and at this *p*H the buffer alone had little effect. Solutions of sodium polypectate, polygalacturonic acid and pectin had an optimum *p*H for activation of 4·5, and the buffer alone had a slight activating action at this *p*H. Monogalacturonic acid also activated the phenolase, but was less effective than the polymers; with carboxymethylcellulose, activation was most rapid between *p*H 4·0 and 4·5.

It is likely that soluble pectic substances are liberated from walls during the invasion of tissues by *Botrytis fabae* because the fungus readily produces polygalacturonase in culture. Enzymatic hydrolysis of sodium polypectate and pectin to short-chain polymers did not destroy the ability to activate the phenolase.

Filtrates from cultures of *B. fabae* on certain media containing pectic substances rapidly reduce the viscosity of pectic substances in solution. These filtrates also disintegrate bean stem tissue, but if leaf extracts are included in the original media the filtrates have little or no polygalacturonase activity, and do not disintegrate stem tissue. Other results suggested that the enzyme was inactivated by substances formed following the oxidation of phenols in the leaf extract, and direct evidence for this was obtained in the following experiment. Phenolase was activated by carboxymethylcellulose at *p*H 4·0 and allowed to oxidize DOPA at *p*H 7·0 for 6 hr.; red-brown products had now developed. Equal volumes of oxidized DOPA and *B. fabae* culture filtrate were mixed at *p*H 7·0. Viscosity-reducing activity changed little over 2 hr. in the control with DOPA, but in the presence of oxidized DOPA, although there was no immediate effect, activity was markedly reduced after 10 min., and, after 1 hr., polygalacturonase activity was very low.

From these and other experiments, it would appear that the formation of a chocolate spot results from an interaction of the polygalacturonase systems of the fungus and the phenolase systems of the host. Fungal polygalacturonase probably kills host cells rapidly[3] and liberates the phenolase system. It also degrades cell walls and so liberates pectic substances which have been shown to activate host phenolase between *p*H 4·0 and 5·0. This will be followed by the oxidation of host phenols and the formation of dark brown polymeric products, which now inactivate the polygalacturonase of the pathogen.

A hypothesis based on interactions of this sort could explain why chocolate spot lesions are generally limited in size and why the tissue of the lesion remains coherent for some time.

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Absorption and Breakdown of Iron–Ethylenediamine Tetraacetic Acid by Tomato Plants

Jacobson[1] was the first to show that plants could utilize iron supplied as the ferric chelate of ethylenediamine tetraacetic acid (Fe–EDTA). Subsequent workers[2,3] have concluded from experiments with isotopically labelled chelating agents that the iron was released after the uptake of the entire molecule by plant roots. Tiffin and Brown[4], however, showed that, at least initially, iron was absorbed by roots from a phenolic analogue of Fe–EDTA while most of the chelating agents remained in the culture solution. The absorption of Fe–EDTA was therefore further examined, using the iron chelate labelled in both portions of its molecule.

Tomato plants were raised from seed germinated in acid-washed sand and grown in an iron-free nutrient solution in the glasshouse. Ten days after the first true leaves had appeared, three plants of uniform size were transferred to each of six culture dishes. The nutrient solution included 1 p.p.m. of iron as Fe–EDTA, prepared from equimolar amounts of ferric chloride labelled with iron-59 and EDTA labelled with carbon-14 in the 2-position of the acetate group. The stability of the iron chelate in the nutrient solution was checked by keeping a further replicate free from plants under the same experimental conditions. During the experiment light was excluded from the nutrient solution and its *p*H was maintained at 5–6.

After 10, 17 and 24 days the plants and nutrient solution in two dishes were taken for isotope analysis. The plants in each dish were bulked, divided into tops and roots and dried at 65° C. overnight. For iron-59 assay, the material was digested with nitric and perchloric acids and the γ-radiation measured in a scintillation counter. For carbon-14, the plant material was oxidized with a Van Slyke acid mixture, the carbon-14 was collected as barium carbonate and counted under an end-window Geiger–Müller tube[5]. Solutions were evaporated to dryness in the presence of inactive carrier before oxidation and assay. No iron-59 was present in the barium carbonate precipitates. The iron-59 counts were converted to μgm. iron; carbon-14 results were expressed as μc. since the chemical form of this isotope was uncertain (Table 1).

Almost all the added iron was recovered either from the solutions or from the plants; by contrast the carbon-14 recovered fell steadily to about 60 per cent of its original value after 24 days, indicating decomposition of the EDTA. Both isotopes were almost completely recovered from the solution in which no plants were grown. The loss of carbon-14 was therefore not due to decomposition of the Fe–EDTA in the nutrient solution, but to absorption and breakdown in the plants.

After 10 days the plants had absorbed about 41 per cent of the added iron but only 26 per cent of the carbon-14. As there was no decomposition in the nutrient solution these figures imply that the plant roots had absorbed both iron and iron chelate. Later results showed that while the rate of uptake of iron decreased with time, that of the carbon-14 (EDTA) continued steadily. The EDTA liberated by the absorption of iron probably chelated other metals, for example, copper, zinc and manganese, in the nutrient solution. Subsequent absorption of these chelates would explain the steady increase in carbon-14 content and the progressive increase in the ratio of carbon-14 to iron in the plant tops.

This is the first report of experimental evidence that EDTA is broken down during the utilization by plants of the iron chelate, although it has been suggested previously that the iron might be released during breakdown of the chelate in leaves by sunlight[6].

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Table 1

Duration of sampling date	Nutrient solution		Plant roots		Plant tops		Total recovery as percentage of original solution	
	μgm. Fe	μc. C-14	μgm. Fe	μc. C-14	μgm. Fe	μc. C-14	Fe	C-14
0 days (original solution)	200	9·04					100	100
10 days	122·7 111·5	6·98 6·29	14·6 15·0	0·30 0·40	55·6 65·0	0·11 0·11	96·5 95·8	81·8 75·2
17 days	75·0 90·0	5·47 5·92	22·9 31·3	0·82 0·59	93·4 68·9	0·24 0·17	95·7 95·1	72·2 73·9
24 days	81·0 84·6	3·87 4·49	30·0 29·4	0·81 0·57	81·1 70·6	0·35 0·63	96·1 92·3	55·6 62·9
24 days*	197·8	9·11	—	—	—	—	98·9	100·8

* This dish of nutrient culture solution contained no plants.

A Lipoprotein Staining Method for Zone Electrophoresis

In an attempt to overcome some of the well-known disadvantages of the commonly used lipoprotein stains, a new method, based on the use of Schiff's stain after preliminary ozonization, was developed. It does not depend on the use of lipid stains, and, consequently, washing the stain out of the background is not necessary. Furthermore, it can be used equally well on cellulose acetate material and on filter paper.

The electrophoretic separation is performed in the usual manner, but a somewhat larger sample than that used for ordinary protein separation is recommended. When the separation is completed, the

strip is dried under a fan or in a hot-air oven at a temperature preferably not exceeding 80° C., and placed in a chamber for ozonization. The ozone can be introduced from an ozonizer or it can be generated chemically inside the chamber. I have been using a barium peroxide–concentrated sulphuric acid method which is both simple and cheap. A small glass container with the barium peroxide powder is placed inside the ozonizing chamber (a large jar or glass tank with a closely fitting lid, the size depending on the number and size of the strips) and a small volume of concentrated sulphuric acid is poured over the barium peroxide. The lid of the chamber is then quickly closed. The necessary amounts of the reagents will vary with the capacity of the chamber. After about 15–30 min. the strip is removed from the ozone atmosphere, rinsed in *N*/1,000 hydrochloric acid, and placed in Schiff's stain (prepared as for glucoprotein staining) until the lipoprotein bands acquire their maximum colour intensity. This usually takes about 5–15 min., but the staining time does not appear to be critical and the strips can be left for longer periods of time. When staining is completed, the strip is transferred into a reducing solution, for example, potassium metabisulphite crystals in *N*/10 hydrochloric acid. A thorough washing in three consecutive reducing baths is essential if the background is to remain colourless. A final wash in plain *N*/10 hydrochloric acid is recommended. The strip is then blotted and dried at room temperature. It was found that instead of the reducing bath, a 2–3 per cent aqueous nitric acid solution can be used with almost equally satisfactory results, with the advantage of not having to prepare the reducing solution each time and avoiding the irritating smell of sulphur dioxide. As an alternative to the preliminary exposure to ozone, quite satisfactory results can also be obtained by immersing the strip for about 20 min. in a 2–3 per cent solution of iodic acid, or in a 5 per cent aqueous potassium iodide solution which has been left standing in the light for a few days acquiring a very pale yellow tinge. It should then be kept in the dark. The intensity of colour of the lipoprotein bands, however, will not reach that obtained after ozonization.

The results are shown in Figs. 1 and 2. In normal human serum two lipoprotein fractions are usually seen, but it should be noted that on cellulose acetate the main lipoprotein fraction of the serum travels with α_2 mobility and not with the β fraction as on filter paper. The stained bands obtained by this method coincide exactly with those obtained with any of the conventional lipid stains such as sudan black. This can be seen by comparing the bands with parallel lengths from the same strip by the ozone – Schiff and sudan black methods respectively (Fig. 1).

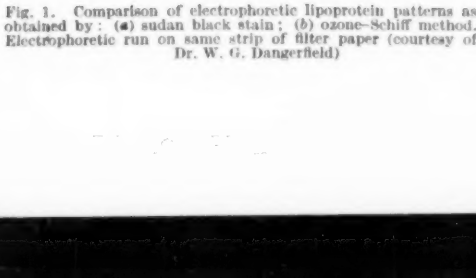

Fig. 1. Comparison of electrophoretic lipoprotein patterns as obtained by: (*a*) sudan black stain; (*b*) ozone–Schiff method. Electrophoretic run on same strip of filter paper (courtesy of Dr. W. G. Dangerfield)

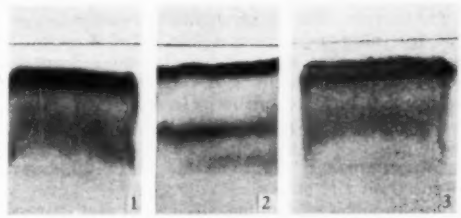

Fig. 2. Lipoprotein patterns of human serum on cellulose acetate obtained by (1) ozone–Schiff method; (2, 3) potassium iodide–Schiff method

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PHYSIOLOGY

Some Pharmacological Actions of D-Lysergic Acid Methyl Carbinolamide

D-Lysergic acid methyl carbinolamide, $C_{16}H_{21}N_3O_2$, is a new alkaloid produced by a strain of *Claviceps paspali* Stewens and Hall. Arcamone, Bonino, Chain, Ferretti, Pennella, Tonolo and Vero[1] isolated the new alkaloid from submerged cultures and determined its structure. I have now investigated some of the pharmacological actions of the new alkaloid.

D-Lysergic acid methyl carbinolamide was kindly supplied to me by Prof. E. B. Chain. Freshly prepared aqueous solutions of the maleate salt ($C_{16}H_{21}N_3O_2.C_4H_4O_4$) were used in my experiments.

The intravenous *LD*50 of the new alkaloid was approximately 150 mgm./kgm. for mice and 0·75 mgm./kgm. for rabbits. Before death, the mice showed periodic convulsions of a clonic type, erection of the hairs and excitability. At doses of 50–100 mgm./kgm. it produced only this peculiar symptomatology: the mice stood upright and pressed on each other's noses and chattered their teeth. In rabbits, an injection into the ear vein in doses of 0·1–1 mgm./kgm. produced dilatation of the pupil, excitability or convulsions of a clonic type. The ears became pale and cold with intense vaso-constriction. The toxicity of the alkaloid to rabbits seemed to depend on its power of raising the body-temperature in this species. In rabbits the similarity between the effects of the new alkaloid and ergometrine were particularly striking, but ergometrine was less toxic to rabbits (the approximate intravenous *LD*50 of ergometrine was 3·5 mgm./kgm.).

D-Lysergic acid methyl carbinolamide induced, in low concentrations (minimum active concentration 0·1–1 μgm./ml.), a contracture in the isolated uterus of the virgin guinea pig. There was a satisfactory dose/response relationship. This contracture was very similar to that produced by ergometrine maleate, which, however, was 1–2 times more potent.

On the rabbit uterus *in situ* both alkaloids produced a prompt contraction and increased rhythmic activity

of the uterus. For ergometrine the minimum active dose by intravenous route was 0·1–0·3 mgm./kgm. and for the new alkaloid 0·2–0·5 mgm./kgm. The actions of both alkaloids lasted some minutes, and owing to the favourable circumstance that the interference between the effects of the two alkaloids was negligible, it was possible to test them on the same preparation. Ergometrine was 1–2 times more potent than the new alkaloid.

On the isolated seminal vesicles of the guinea pig, the new alkaloid was approximately 200 times less potent than ergotamine tartrate as an adrenergic blocking drug.

Rabbits anæsthetized with urethane supported doses of D-lysergic acid methyl carbinolamide which would have killed unanæsthetized animals. Rapid intravenous injections of small doses (0·1–0·2 mgm./kgm.) of the new alkaloid caused an evanescent decrease or a small increase of blood pressure; with higher doses (0·3–0·5 mgm./kgm. and more) the blood pressure increased moderately without showing any dose/response relationship. Ergometrine maleate seemed to be less active on blood pressure, and there was no significant change of blood pressure with 0·3–0·5 mgm./kgm.

The new alkaloid was without effect, when given in small doses, on the blood pressure of cats anæsthetized with chloralose. Higher intravenous doses (0·1–0·3 mgm./kgm.) caused a sustained hypotension of long duration and a moderate decrease of heart-rate. The respiration of rabbits and cats was depressed by small doses of the new alkaloid; cats seemed to be less resistant than rabbits. In cats, 0·01 mgm./kgm. of the new alkaloid caused broncho-constriction and contraction of the nictitating membrane of long duration.

The new alkaloid had no action on isolated rabbit auricles at doses up to 100 μgm./ml.

In summing up, the new naturally occurring alkaloid D-lysergic acid methyl carbinolamide has powerful ergometrine-like oxytocic actions and weak ergotamine-like adrenergic blocking actions. It must be included, on the basis of pharmacological evidence, in the ergometrine group of ergot alkaloids. Ergometrine, however, is less toxic and more active than the new alkaloid. Some of my results suggest that it could have a lysergic acid diethylamide-like activity, but this hypothesis must be checked by experiments on humans.

Full details of this work will be published elsewhere.

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Repression and De-repression of Enzyme Synthesis as a Possible Explanation of some Aspects of Drug Action

According to recent theories, the induction of enzyme synthesis occurs as a result of the displacement from an enzyme-forming system of a natural repressor[1]. For example, the synthesis of alkaline phosphatase by *E. coli* is normally repressed by inorganic phosphate[2]. De-repression occurs when there is only a small amount of inorganic phosphate in the medium. The repressor theory is in good agreement with most of the observations which have been made on enzyme-inducing systems. The inducer need not be a substrate for the enzyme which is formed, nor need it serve as a template for the formation of new enzymes[1].

While this phenomenon is best known from work with bacteria, examples of the de-repression of various mammalian enzymes have also been reported[3]. Especially interesting are instances of the apparent de-repression of enzymes which metabolize certain drugs and carcinogens. There is an enzyme system in liver microsomes which, in the presence of reduced triphosphopyridine nucleotide and oxygen, can carry out a number of 'detoxifying' reactions. These include: the hydroxylation of aromatic rings, the O-dealkylation of aromatic ethers, the N-dealkylation of substituted amines, reductive cleavage of diazo groups, and the oxidation of alkyl side-chains. There are probably several different enzymes involved, but they all have similar requirements, and all are inhibited by diethylaminoethyl-diphenylpropyl acetate (*SKF 525-A*)[4].

Many of the known substrates of the reduced triphosphopyridine nucleotide – oxygen – microsomal system, and some compounds of similar structure, can produce marked de-repression of various enzymatic activities when injected into young rats. Examples of such increased enzyme synthesis are: increased hydroxylation of 3,4-benzpyrene[5] and 2-acetylaminofluorene[6]; and increased N-demethylation and reductive cleavage of azo dyes[7,8]. Actual enzyme synthesis is believed to be taking place in these instances because treatment with ethionine prevents such increases in enzyme activity and this inhibition is overcome by methionine.

Another enzyme system which can be de-repressed by the same treatment is that which converts glucose to glucuronic acid and ascorbic acid. This de-repression leads to striking increases in excretion of ascorbic acid and glucuronic acid by treated rats [8–10]. There is also increased conversion of glucose-^{14}C to glucuronic acid and ascorbic acid[9]. The increased excretion of ascorbic acid appears considerably later than the rise in activity of the reduced triphosphopyridine nucleotide–oxygen–microsomal system, and may perhaps be a secondary response to increased synthesis of glucuronic acid. It can be pointed out that the detoxified products of the microsomal system are usually further metabolized as glucuronides[4]. While barbital is not metabolized by the microsomal system which 'detoxifies' other barbiturates, it can nevertheless produce the same type of de-repression[8].

It may well turn out that the physiological substrates of both the 'detoxifying' microsomal system and the glucuronide-synthesizing system are actually steroids. The injection of 3-methyl cholanthrene or related carcinogens increases the hepatic metabolism of hydrocortisone[11]. Compounds such as methyl cholanthrene, benzpyrene and dibenzanthracene could act as de-repressors by virtue of their similarity to natural steroid repressors. These carcinogens are known to potentiate the biological activities of steroids[11]. There is a sex difference in the activity of the microsomal system in adult rats. This produces marked differences in the rates of detoxification of hexobarbital[4] and the N-demethylation of morphine[12]. Such sex differences can be altered in either direction by treatment with sex hormones, and this may represent an example of repression and de-repression by steroid hormones.

Examples of drug-induced enzyme repression can also be found. An outstanding case is the striking decrease in N-demethylase activity found by Axelrod in the liver microsomes of rats made tolerant to morphine[12]. This was suggested as a model system for the phenomenon of drug tolerance as seen in narcotic addiction[13,14]. It was postulated by Axelrod that continued exposure to morphine might lead to a similar inactivation of a receptor site in the central nervous system. This theory does not explain the development of physical dependence as manifested by the appearance of withdrawal symptoms.

The concept of drug-induced repression of enzyme synthesis can be used to formulate a scheme which serves to explain the features of tolerance to, and physical dependence on, narcotics like morphine as shown in Fig. 1.

According to this scheme, morphine can act at two sites. By inhibiting at site *A* the action or synthesis of a neurohormone required for proper functioning of the central nervous system, it can bring about its characteristic effects of depression of the central nervous system, analgesia and sedation.

On repeated administration (or on a few treatments with very high doses[14]) morphine also begins to act at site *B*, causing de-repression of the system which makes the neurohormone-synthesizing enzyme. This would increase the amount of neurohormone acting on the central nervous system. Tolerance to the depressant effects of morphine develops because more morphine is now required to depress the central nervous system.

Another way in which the same result could be achieved is also indicated in Fig. 1. Instead of acting at site *B*, morphine could increase the concentration of neurohormone by repressing, at site *C*, the synthesis of an enzyme which destroys the neurohormone. Such a repression would be similar to the repression by morphine of the synthesis of morphine N-demethylase.

When morphine is afterwards withdrawn, the increased amount of neurohormone is no longer 'neutralized' by morphine, and the result is the excitation of the central nervous system typically observed as withdrawal symptoms. This creates an apparent physical dependence on the narcotic, since these symptoms are readily controlled by a resumption of morphine administration. The withdrawal symptoms gradually diminish in intensity as the concentration of neurohormone returns to normal and tolerance also disappears. The morphine antagonist N-allylnormorphine can precipitate withdrawal symptoms in an addicted animal by competing with morphine for site *A* and thus unmasking the effects of an increased concentration of neurohormone.

The examples given here indicate that the concept of repression and de-repression of enzyme synthesis may prove useful in understanding how drugs can modify the biochemical mechanisms which make for a normal homeostatic condition in the mammalian organism.

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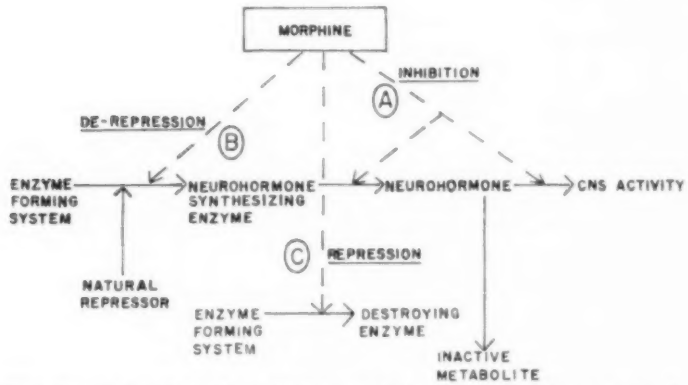

Fig. 1. Hypothetical scheme for explaining some of the actions of morphine in terms of repression and de-repression of enzyme synthesis

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Glutamic Oxalacetic Transaminase Activity in Different Zones of the Ventricular Muscle of the Dog

Of the tissues of several animal species the myocardium has the highest concentration of glutamic oxaloacetic transaminase (GOT)[1-3]. Distribution of this enzyme in several zones of the cardiac muscle has received but scant attention in the literature. However, it has been shown that the dog's left ventricle has a higher GOT activity than the right one[4], and a similar difference has been described for the concentration of adenosine triphosphatase and succinic dehydrogenase[5]. On the other hand, Jennings, Kaltenbach and Smetters failed to note significant differences in the left ventricle of the dog between the GOT activity of the posterior papillary muscle, the left ventricle immediately beneath, and the anterior superior septum[6]. The present observations show that GOT activity of the myocardium is not uniform, and that there are significant differences in dogs among several zones of both ventricles.

Six male and four female adult mongrel dogs, weighing between 5 and 8 kgm. were anæsthetized with sodium pentobarbital (33 mgm./kgm.); the heart was removed and two small muscle samples from each one of the following zones of the ventricles were excised: (*a*) outer surface from the middle part of the free wall (to be called left epicardium); (*b*) inner surface of the free wall beneath the removed epicardial zone (to be called left endocardium); (*c*) muscle lying between the two formerly described (to be called mesocardium); (*d*) inner endocardial layers from the middle part of the left side of the septum (to be called septum). In six further dogs (four male and two female), (*a*) and (*b*) were removed simultaneously with (*e*) outer surface from the middle part of the right free wall (to be named the right epicardium) and (*f*) inner ventricular surface beneath the previous one (to be named right endocardium). Twenty mgm. were immediately weighed from each sample in a torsion balance to the nearest mgm., and cut in 10-μ sections with a freezing microtome. The enzyme was extracted by incubation at 2–4° C. for 30 min. in phosphate buffer at *p*H 7·4. Enzyme activity was determined by a modification of the technique of Cabaud, Leeper and Wroblewski for blood serum[7]. Incubation was carried out at 25° C. for 20 min. with D,L-aspartic and α-keto glutaric acids as substrate. All observations were performed 'blindly' in duplicate; results were compared with Student's *t* test according to Fisher and Yates's Tables[8].

The results expressed in μmoles of pyruvate liberated per mgm. of wet tissue under the stated conditions are shown in Tables 1 and 2. Error of the method ($e = \frac{Sm \times 100}{\bar{X}}$; where Sm = standard error of the mean; $\bar{X}$ = mean of observations) was found to be ± 0·81 per cent on 16 duplicate determinations and performed on one ventricular sample. As can be seen the GOT activity of the left endocardium (1·126 ± 0·041 *S.E.*) is higher than that of the left epicardium (0·817 ± 0·036). The enzymatic activity of the mesocardium (0·946 ± 0·029) lies between both, while in the septum (0·971 ± 0·027) it is lower than in the left endocardium. No significant differences in enzymatic activity are noted between the septum and the mesocardium. On the other hand, the right epicardium has a higher concentration than the right endocardium (1·205 ± 0·088 and 0·949 ± 0·063, respectively).

The high concentration of the GOT in the myocardium[1–3] may indicate that this enzyme has an important bearing on cardiac metabolism. Nevertheless, very little is known about the relationships existing between such an enzymatic activity and the main manifestations of cardiac activity, namely, bioelectric and contractile phenomena. Transamination reactions provide anaerobically certain metabolites (oxaloacetic and pyruvic acids, for example) which are aerobically oxidized stepwise by mitochondrial enzymes of the Krebs cycle, liberating a great amount of energy. In this connexion it has been pointed out that the cardiac muscle can use these metabolites to supply a large part of the energy required to support the contractile activity of the myocardium[5].

Table 1. GOT Activity in Different Zones of the Left Ventricle

Zone	No. of determinations	GOT in μmoles of pyruvate/mgm. of wet tissue
(1) Epicardium	20	0·817 ± 0·036
(2) Endocardium	20	1·126 ± 0·041
(3) Mesocardium	16	0·946 ± 0·029
(4) Septum	16	0·971 ± 0·027

t 1 vs. 2 = 5·722, $P < 0·001$; *t* 1 vs. 3 = 2·866, $P < 0·01$; *t* 1 vs. 4 = 3·500, $P < 0·01$; *t* 2 vs. 3 = 3·660, $P < 0·001$; *t* 2 vs. 4 = 3·875, $P < 0·001$; *t* 3 vs. 4 = 0·833.

Table 2. GOT Activity in Different Zones of Both Ventricles

Zone	No. of determinations	GOT in μmoles of pyruvate/mgm. of wet tissue (mean ± standard error of the mean). Right ventricle	No. of determinations	GOT in μmoles of pyruvate/mgm. of wet tissue (mean ± standard error of the mean). Left ventricle
(1) Epicardium	11	1·205 ± 0·088	11	0·956 ± 0·061
(2) Endocardium	12	0·949 ± 0·063	10	1·201 ± 0·077
t 1 vs. 2		2·370, $P < 0·05$		2·525, $P < 0·01$

It is probable that differences in enzymatic activity may be related to functional differences of the myocardium, since metabolic activity determines the fundamental properties of the cardiac fibres. Our findings indicate that the free wall of the left ventricle shows an enzymatic concentration that falls progressively from the endocardium to the epicardium. Furthermore, the samples from the left endocardial surface of the septum show a lower enzymatic activity than those from the endocardium of the left ventricular free wall. On the other hand, in the right ventricle the epicardium has a higher enzymatic concentration than the endocardium. When it is considered that some of the bioelectric properties, for example, rate of repolarization, are not the same in different zones of the myocardium[10], it seems worthwhile to study the relationships, if any, of these properties and transamination activity.

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Inhibiting Effect of 2 : 4-Dinitrophenol on Calciferol-induced Metastatic Calcification in the Rat

PREVIOUS investigations by Trout[1] and by us[2] indicate clearly that the deposition of mineral in the aortæ of calciferol-intoxicated rats continued long after cessation of administration of this compound and after the blood calcium-level had returned to normal. It appears that, once initiated, this process follows an irreversible course, at least in the aorta, since even 160 days after the initial insult there was no evidence of a reduction in the mineral content of the aorta. Attempts to inhibit calciferol-induced calcification of the aorta by the simultaneous administration of papain (which reduces the mucopolysaccharide content of the aorta) were unsuccessful[3].

Since the calcification is accompanied by a large increase in aortic phosphorus content, it was decided to investigate the effect of 2 : 4-dinitrophenol (DNP) on the action of calciferol administered simultaneously; for it has been shown by Whitehead and Weidman[4] that DNP *in vivo* inhibits the synthesis of adenosine triphosphate, as measured by the incorporation of phosphorus-32, and also the incorporation of the isotope into the bone salt of kitten cartilage. Gutman and Yii[5] found that calcification *in vitro* was markedly inhibited by 2 : 4-dinitrophenol at 10^{-4} *M* concentration. Whitehead and Weidman suggested that the relationship between phosphorus-32 incorporated into bone salt and adenosine triphosphate is that the latter is required to initiate the formation of a primary seed which acts as a nucleus for the subsequent deposition of bone salt.

Accordingly, 20 male Wistar strain rats, initially weighing approximately 250 gm., were divided randomly into four groups of five. Group I was given, twice daily, intraperitoneal injections of 3 ml. of 0·9 per cent sodium chloride solution for twenty days. Group II received identical saline injections, together with calciferol (a total of 100,000 units/kgm. body-weight) given orally, in daily doses, as a solution in arachis oil from day 6 to 10 inclusive. Group III were given, twice daily, injections of 3 ml. of a saturated solution of DNP in 0·9 per cent sodium chloride, while Group IV received the same injections together with calciferol orally as in Group II. On day 20 the animals were killed and the aorta, lungs and stomach dissected out. The tissues were dehydrated with acetone, defatted with ether–alcohol (1 : 1 v/v) and dried to constant weight at 100° C. A second series of animals received the same treatment, but were killed on day 9 of the experiment, that is, 4 days after starting calciferol treatment, and bled from the heart; the serum was analysed for calcium and inorganic phosphorus. Differences between means were assessed by the Mann–Whitney *U* test, using the 5 per cent level of significance.

Table 1 shows the mean aortic dry weight and the calcium and phosphorus contents of the aortæ. Calciferol treatment resulted in an approximately two-and-a-half-fold increase in mean aortic dry weight, similar to that previously found by us[2]. We have found this increase in weight to be due largely to the increased mineral content of the aortæ (see below). For this reason, the results for calcium and phosphorus are expressed in mgm./aorta. It will also be seen from Table 1 that DNP, administered simultaneously with calciferol, significantly reduced the effect of calciferol on total aortic weight, although

Table 1. DRY WEIGHT AND MINERAL CONTENT OF RAT AORTÆ

Group	Treatment	Dry fat-free weight (mgm.)	Calcium (mgm./aorta)	Phosphorus (mgm./aorta)	Calcium/phosphorus ratio
I	Saline only	16·7 ± 1·2*	0·21 ± 0·06	0·07 ± 0·01	3·0 : 1
II	Saline + calciferol	43·8 ± 5·5	6·23 ± 0·91	2·30 ± 0·33	2·7 : 1
III	DNP only	16·7 ± 1·0	0·11 ± 0·01	0·08 ± 0·01	1·4 : 1
IV	DNP + calciferol	28·1 ± 4·0	2·88 ± 1·04	1·15 ± 0·31	2·5 : 1

* Mean ± *S.E.*

DNP alone had no effect at all on the aortic dry weight.

Calciferol treatment also resulted in significant increases in both calcium and phosphorus contents of the aorta; DNP alone had no effect on these constituents, but when given simultaneously with calciferol, significantly reduced the degree of mineralization induced by calciferol, by approximately one-half. The calcium–phosphorus ratio of the aortæ tended to be reduced in the two groups receiving DNP injections, but, due to wide variations in individual values, the differences were not significant.

Results similar to those from aortæ were obtained for lung and stomach; for calciferol produced significant increases in the calcium and phosphorus contents of these organs as well[2] and DNP, given simultaneously, reduced this effect.

The results of the serum calcium and phosphate determinations showed that calciferol markedly increased both these serum constituents (calcium–phosphorus product raised to 125 compared with control value of 77). However, despite its marked effects on tissue mineralization, DNP given simultaneously with calciferol did not affect the increases in serum calcium and phosphorus induced by calciferol.

Hence it would appear that the inhibiting effect of DNP on the calcification induced by calciferol is not mediated via any overt action on blood calcium or phosphate-levels. It would thus seem to exert some direct effect on the tissues, although an indirect action, via the endocrine system, for example, parathyroids, cannot be ruled out at present.

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Function of the Hypophysis–Thyroid System in the Rabbit Fœtus with Regard to Cholesterol Metabolism

The experimental studies of Jost[1] and Hwang and Wells[2] have demonstrated the functional interrelationship of the pituitary and thyroid in the rabbit and rat fœtus. Rumph and Smith[3] showed that the thyroid of the 90-mm. pig fœtus contains a substance which would induce metamorphosis in the hypophysectomized tadpole. Geloso[4] demonstrated the presence of thyroid hormones in the blood of the rat fœtus. Jost and Picon[5] showed that fœtal thyroidectomy resulted in an increase in total body fat in the rabbit fœtus. Bearn[6] found an increase in liver fat following hypophysectomy by decapitation in the rabbit fœtus, and correlated this with the increase in the fat content noted in human anencephalic fœtuses. These experiments can be taken to indicate that the fœtal thyroid is capable of function, and that its function is regulated by the fœtal pituitary.

It is well known that there is in both adults and in infants a close relationship between thyroid function and cholesterol metabolism. A rise in blood cholesterol has been reported in hypothyroidism[7] and in cretinism[8]. It was therefore decided to investigate the role of the pituitary and thyroid of the rabbit fœtus in the regulation of cholesterol metabolism.

Nineteen rabbit fœtuses were decapitated by a modification of the method described by Jost[9]. Nine fœtuses were decapitated through the neck to remove the thyroid as well as the pituitary, and ten were decapitated through the mouth to preserve the thyroid. The operation was performed between days 21 and 23 following witnessed mating, and the fœtuses were recovered after seven days of further intrauterine development; 53 litter mates were used as controls.

The cholesterol-level of the blood was determined blind by the method described by Abell *et al.*[10], and the results expressed in mgm. per 100 ml. As used in this laboratory, the method has a standard error of blind duplicates of 8·3 mgm. The results are summarized in Table 1.

Table 1. Cholesterol-Levels in Serum of Decapitated and Control Fœtuses

Fœtuses	Age at investigation	No.	Mean serum cholesterol (mgm./100 ml. ± S.E.)
Low decapitation (at 21–22 days)	28–29 days	9	142 ± 5·2*
Litter mate controls	28–29 days	29	87 ± 2·9*
High decapitation (at 22–23 days)	29–30 days	10	156 ± 6·5*
Litter mate controls	29–30 days	24	97 ± 4·2*

* These differences are significant, $P < 0.001$.

There is a variability in the level of blood cholesterol from one litter to another, but the level in each of the control fœtuses from a single litter shows little variation.

The decapitated fœtuses all showed a significant rise in blood cholesterol, even in those fœtuses in which the thyroid was left behind and only the pituitary removed.

These preliminary results indicate that the fœtal pituitary and thyroid play a part in the cholesterol metabolism of the fœtus. In addition, they indicate that maternal thyroid hormones and maternal thyrotropic hormone do not compensate for the absence of fœtal thyroid and pituitary hormones in the rabbit.

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Rate of Anaerobic Glycolysis versus Structure in Pork Muscle

The *p*H of pork musculature after cessation of post-mortem glycolysis (ultimate *p*H) has long been known to be decisive for structure and water-holding capacity of the muscle. Recent observations[1,2] have shown that considerable variation in structure of muscle with the same ultimate *p*H may be recorded. The rate of the post mortem *p*H fall was found to be of considerable importance.

The investigations which are briefly reported here were facilitated with a *p*H meter (Radiometer model No. 31; electrode-elector type *ELS*31; electronic recorder type 153, Honeywell) for continuous and simultaneous *p*H and temperature recordings. Six *p*H electrode pairs (glass electrodes *G* 2326, calomel electrodes 4116) were inserted in representative muscles and permitted to remain in position from 1 to 24 hr. post mortem. Careful tests have not revealed any indications of artefacts arising from this procedure. The carcasses from 20 Danish Landrace pigs (85–95 kgm.) were used in this work. The continuous recordings from these carcasses depict at least four distinct types of post mortem *p*H patterns: (1) A slow gradual decrease to an ultimate *p*H of 5·7–6·3. (2) A gradual decrease to approximately 5·7 at 8 hr. with an ultimate *p*H of 5·3–5·7. (3) A relatively rapid decrease to approximately 5·5 at 3 hr. with an ultimate *p*H of 5·3–5·6. (4) A sharp, significant decrease to a *p*H of approximately 5·1 at 1½ hr. and a subsequent elevation to 5·3–5·6.

The anaerobic glycolysis of the type 4 compared to the type 2 *p*H pattern and the effect on the tissue of the longissimus dorsi muscle will be briefly elaborated.

A Radiometer *p*H meter (model 24) was used to determine *p*H values at 15-min. intervals to the 1-hr. period while the carcasses were in the slaughter line. Afterwards the carcasses were transferred to a 3° C. atmosphere for continuous recordings (*p*H

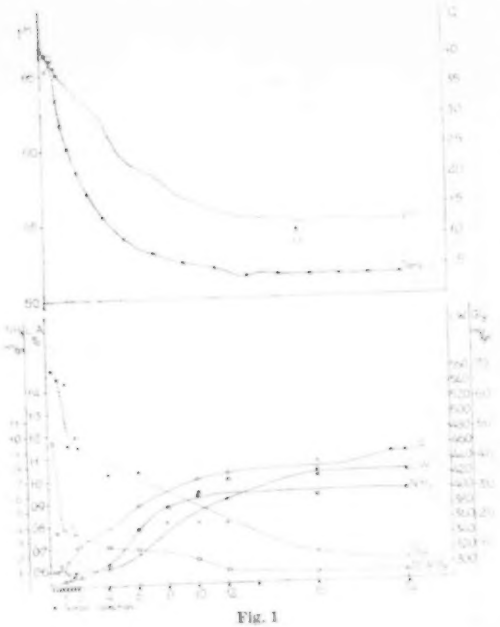

Fig. 1

and temperature) from 1 to 24 hr. Thermocouples and electrodes were uniformly placed in the muscle in the area of the second lumbar vertebra. Samples of the longissimus dorsi from the twelfth rib to the last lumbar vertebra of the opposite side were secured, for analysis, at various intervals as indicated in Fig. 1.

The results in Fig. 1 show the features of a slow rate of anaerobic glycolysis (type 2), those in Fig. 2 depict the rapid rate of the type 4 muscle. In the type 4 muscle *p*H decreased to 5·1–5·2 in 1½ hr., while the temperature was 36–40° C. In the type 2 muscle the lowest *p*H around 5·5 was not reached until the temperature approximated 4° C. The difference in the rate of *p*H fall was due to difference in rate of anaerobic glycolysis as illustrated by the glycogen[1] and lactic acid[2] determinations. The type 4 muscle initially contained a relatively high percentage of protein-bound glycogen. This may be seen by comparison of the amounts of glycogen soluble in trichloracetic acid in a single rapid extraction[4,5]. The liberation of ammonia[6] and depletion of labile phosphate (7P) (ref. 7) suggest that rigor mortis occurred during the first 30–45 min. in the type 4 muscle, compared to 4–6 hr. post mortem for the type 2 muscle. It was furthermore noticed that the decrease in temperature during the first 2 hr. was comparatively slow in the type 4 muscle, apparently due to the heat of the rapid glycolytic reactions.

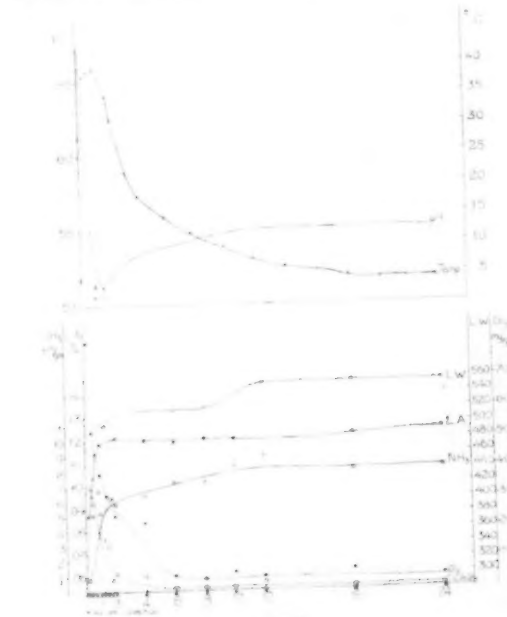

Fig. 2

The effect of *p*H and onset of rigor mortis on the water-holding capacity of the tissue is depicted by the 'loose-water' (LW) number which gives the amount of water in mgm. which can be pressed out of 1 gm. meat under standardized conditions[3]. In the type 4 muscle these numbers rise very sharply to high values and the meat assumed a pale colour. These changes suggest partial denaturation of the meat proteins[1].

The sharp pronounced elevation in the type 4 *p*H curve appears connected to partial denaturation of the muscle proteins. In this context it is interesting to note that the proteins of the type 4 muscle show increased affinity for safranine and orange *G* dyes which have been used to determine acidic and basic groups[8]. Furthermore, these proteins bind increased amounts of congo red dye, which is regarded as a sign of denaturation[9]. Average results are reported in Table 1.

Table 1. DYE-BINDING-PROPERTIES (24-HR. SAMPLES)

	Type 2	Type 4
Orange *G**	13·94	17·70
Safranin*	14·44	18·71
Congo red†	8·40 (7·79)‡	9·13 (7·31)‡

* Equiv. per 10^4 gm. protein.
† Mgm. dye-bound/100 mgm. protein.
‡ 15 min. post mortem.

Further support for the importance of the acid–temperature relationship has been shown by repeated trials with sections of the longissimus dorsi muscle. These sections were removed from the carcasses, immediately post mortem, and held at varied temperatures. The sections which were retained at 37° C. for 1½ hr. displayed the characteristics of type 4. Conversely, those which were chilled rapidly seemingly avoided the extreme drop in *p*H and were normal in colour and structure.

Preliminary observations of biopsy samples from six Danish Landrace pigs which ultimately showed the type 2 and type 4 *p*H curves are shown in Table 2. Three weeks prior to slaughter the pigs were anæsthetized with trichloro-ethylene and biopsy samples were removed from the lumbar region of the longissimus dorsi muscle[10]. The biopsy samples of pigs which ultimately showed the type 4 *p*H pattern contained greater total glycogen, higher percentage of protein-bound glycogen and faster phosphorylase activity. Similarly, these pigs possessed a smaller pyruvic acid pool and a greater lactic acid

Table 2. Glycolytic Components (Biopsy Samples)

	Type 2	Type 4
Total glycogen (mgm./gm.)	4·02	7·45
Glycogen (acid-soluble) (per cent of total)	49·64	39·39
Pyruvic acid (mgm. per cent)	2·80	1·13
Lactic acid (per cent)	0·29	0·52
Phosphorylase (mgm. glycogen/gm. tissue/30 min.)	11·38	15·49

concentration. Results to date also suggest that lactic acid is converted to pyruvic acid, *in vivo*[11], at a slower rate in muscles with the type 4 *p*H pattern.

It is hoped to publish a complete account of these investigations elsewhere. One of us (E. J. B.) is grateful to Oscar Mayer and Co., Madison, Wisconsin, for their support (on leave from University of Wisconsin) for the duration of this work.

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HÆMATOLOGY

Deformation of Red Cell Shape induced by *Vipera palestinae* Venom *in vivo*

It has been previously reported[1] that *Vipera palestinae* venom causes *in vitro* disk-sphere transformation of red blood cells in the presence of plasma without producing hæmolysis. This phenomenon could be reversed by suspending the spherical red cells in normal plasma. In the present work an attempt was made to establish whether similar changes of red blood cells occur also *in vivo*.

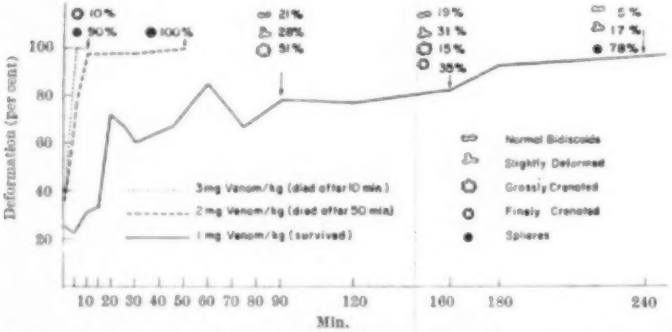

Fig. 1. *In vivo* deformations of erythrocytes of anæsthetized rabbits after intramuscular injection of *Vipera palestinae* venom

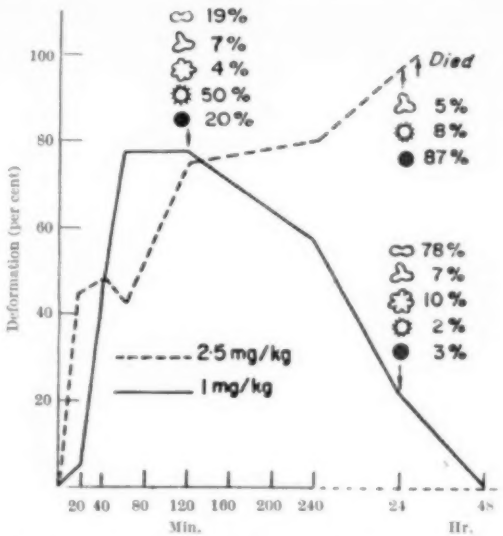

Fig. 2. *In vivo* deformations of erythrocytes of unanæsthetized rats after intramuscular injection of *Vipera palestinae* venom

Sublethal and lethal doses of venom were injected by the intramuscular and intravenous routes to rabbits and rats anæsthetized with urethane or pentobarbital sodium as well as to non-anæsthetized animals. A drop of rat blood from the tail tip was introduced directly into 0·5 ml. of 0·5 per cent osmium tetroxide solution in phosphate buffered isotonic sodium chloride, *p*H 7·2. Rabbit blood samples were drawn from the ear vein or from the jugular vein. Blood cells were examined under the phase contrast microscope, or, after a single washing of the fixed cells with distilled water, in aluminium shadow-cast smears[2], in which the various shapes of 200 erythrocytes were counted. The degrees of deformation observed were classified as follows: (1) normal bidiscoids; (2) slightly deformed cells (the bidiscoid form no longer recognizable, but not yet crenated); (3) grossly crenated cells; (4) finely crenated spheres of small diameter; (5) spheres of small diameter.

In unanæsthetized non-venom-treated animals 95–100 per cent of the red cells were bidiscoid. The majority of the anæsthetized non-venom-treated animals, however, showed some degree of deformation of the red blood cells, ranging from practically 0 to 37 per cent slightly deformed erythrocytes (degree 2). After intramuscular injection of venom the degree of deformation as well as the percentage of cells with a higher degree of deformation increased with time. With increasing doses the changes occurred more rapidly.

Fig. 1 presents the progressive deformation of erythrocytes of anæsthetized rabbits injected intramuscularly with sub-lethal and

lethal doses of venom. The curves represent the percentage of deformed cells, counted after various time-intervals.

Sublethal doses (up to 1 mgm./kgm. intramuscular) induced maximum deformation after about 3 hr. Thereafter reversion to the normal bidiscoid shape began, reaching completion after 6–48 hr. Lethal doses produced rapid progressive deformations, culminating in complete sphering; the higher the venom dose, the earlier this occurred.

Fig. 2 represents the findings in unanæsthetized rats. When a lethal dose (2·5 mgm./kgm. intramuscular) was injected the deformation reached a maximum shortly before the animal died, while no ghosts were observed. This is in agreement with the venom having no direct hæmolytic activity *in vitro*[3]. On the other hand, injection of the venom of *Naja naja* (cobra), known to have direct hæmolytic activity, did produce ghosts. After administration of a sublethal dose (1 mgm./kgm.) reversion of the deformation occurred and was completed after 24–48 hr.

In view of these results it is suggested that the severity of *Vipera palestinae* snake bite might be judged by the study of the degree of deformation of the red cells in a sample of peripheral blood, fixed in osmium tetroxide.

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Di^a, Js^a and V Blood Groups in South and South-East Asia

The red-cell antigens, Di^a and Js^a, are among those of special interest as genetic markers in human populations because they attain reasonable frequency in at least one of the major divisions of the human race, but are rare or entirely absent in all others. The Di^a blood-group factor is restricted to American Indians and Mongoloid populations[1] or those of mixed American Indian ancestry[2]. The more recently discovered Js^a antigen has been detected so far only in the blood of Negroes or of those with the possibility of Negro ancestry[3]. A third blood-group, the Rh antigen V, also may be highly restricted, since it is found most commonly in the blood of Negroes, and only rarely in Caucasians, American Indians or Orientals[4]. The distribution of none of these three antigens, however, has been studied widely in Asiatic populations. We consider it worth while, therefore, to present the results of such a study.

Samples were collected in the field into 'Bayer' venules and allowed to clot. They were sent as soon as possible in ice-cold containers to Perth and were generally tested not more than seven days after collection. Adults only were sampled. Although attempts were made to secure blood from unrelated individuals, this was not always possible in the case of relatively small breeding populations, such as the Veddahs in Ceylon, the Irulas and Kurumbas in south India and the Maco and Yeo tribes in northern Thailand.

All tests were carried out using a standard anti-human globulin reagent prepared at the Commonwealth Serum Laboratories. The reactions were carefully controlled, and only cells were tested which gave a completely negative reaction against the anti-human globulin reagent alone. To check the validity of the Js^a and V reactions cells aged to the same degree were tested with anti-Js^a and anti-V by Dr. Eloise Giblett in Seattle, and known Js^a + ve and V + ve cells sent from Seattle were confirmed by similar reactions in Perth.

The results, as set out in Table 1, show no Js^a + ve or V + ve reactions for 1,274 individuals from twelve ethnic groups in south and south-east Asia. Similarly there were no Di^a + ve individuals among the Veddahs of Ceylon, the Veddoid Irula and Kurumba tribes of South India or among the Tamil, Singhalese, Punjabi or Pathan populations sampled. Di^a + ve reactions were found, however, in Malays, Thais in Bangkok and Chiengmai, the Maco and Yeo tribes in northern Thailand and the Oraon tribe from the Chota Nagpur Plateau in India. Attention should be directed to the single Indian in the sample from Perlis in northern Malaya who gave a Di^a + ve reaction. This person was born in Malaya, and it is possible that there had been some admixture of Malayan blood which introduced the Di^a antigen in this case.

Table 1. Number of Di^a + ve, Js^a + ve and V + ve Reactions in Blood from Various Populations in South and South-East Asia

Ethnic group	No. tested	Di^a + ve	Js^a + ve	V + ve
Ceylon				
Singhalese	93	*	0	0
Tamils	44	*	0	0
Veddahs	39	0	0	0
India				
Kurumbas	45	0	0	0
Irulas	72	0	0	0
Oraons	125	6	0	0
Pakistan				
Punjabis	168	0	0	0
Pathans	139	0	0	0
Thailand				
Thais (Bangkok)	188	14	0	0
Thais (Chiengmai)	124	9	0	0
Maco	40	1	0	0
Yeo	26	1	0	0
Malaya				
Malays	40	1	0	0
Indians	131	1	0	0

* Not tested with anti-Di^a.

These results, together with those reporting the absence of Di^a + ve reactions in Australian aborigines and other Pacific Island populations[5], lend support to the view that the Di^a antigen is restricted to people of Mongoloid descent. But if this is true the presence of 5 per cent Di^a + ve individuals among the Oraons of the Chota Nagpur Plateau merits further study. It is possible that there has been a considerable flow of Mongoloid genes into the tribal populations of eastern India, and we hope to publish elsewhere a more detailed analysis of this problem.

The complete absence of the Js^a antigen reactions in the whole of south and south-east Asia, together with its previously reported absence in Caucasian, American Indian and Polynesian populations, supports the view that this antigen is restricted to Negroes. In this connexion its absence in the Irula and

Kurumba tribes, despite the presence among them of a high sickling frequency[6], is of special interest.

Finally, although there has been relatively little study of the distribution of the Rh antigen V, its complete absence in the present investigation is scarcely consistent with the finding of it in low frequency in Oriental, Caucasian and American Indian populations[4]. Because of its low frequency in these populations, however, a much larger series would be needed to exclude its presence in Asian populations with certainty.

We are indebted to Dr. M. Layrisse for supplying anti-Di^a serum and to Dr. Eloise Giblett for supplying anti-Js^a and anti-V sera, and also for assistance in checking Js^a and V reactions. Mrs. E. I. W. Vos gave us valuable technical assistance and many persons assisted in the collection of blood in the field, particularly Drs. R. L. Wickremasinghe, T. Perera, Ali Mohammed Khan, Sommai Sri-ngarm and Sister D. Piljain. The collection of blood samples was made possible by a South East Asia Treaty Organization fellowship to one of us (R. L. K.) and the cost of air transport of samples was defrayed by a grant from the Australian National Health and Medical Research Council. The University of Western Australia also gave generous financial assistance.

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PATHOLOGY

Antibodies against Autologous Brain in Rats with Allergic Encephalomyelitis

It is known that rats and other animals injected with nervous tissue emulsified in Freund's adjuvant may develop allergic encephalomyelitis within 2–3 weeks[1–3]. Many of the injected animals, irrespective of whether they develop encephalomyelopathy, produce complement-fixing antibodies which specifically react *in vitro* with homologous or heterologous brain extracts[4–6]. The role of these complement-fixing anti-brain antibodies, however, in the pathogenesis of allergic encephalomyelitis remains unknown.

Paterson[7] has recently shown that allergic encephalomyelitis may be transferred in rats using lymph node cells from donors injected with nervous tissue-adjuvant. In this work, complement-fixing anti-brain antibodies appeared in the sera of many recipients, whether or not they developed allergic encephalomyelitis. For this reason, it could not be concluded whether the lesions in the recipients were caused by anti-brain antibodies released by the lymph node cells following transfer and/or by the transferred lymph node cells themselves.

Direct evidence that circulating antibodies are important in production of allergic encephalomyelitis, by passively transferring the disease using serum, has not been reported. Attempts by various workers (see review by Chase[8]) to accomplish transfer in this manner have failed. Kabat *et al.*[9] suggested that failure to transfer allergic encephalomyelitis by serum might well be due to continual absorption of circulating antibodies by the donor's own (autologous) brain. Indeed, Kabat, Wolf and Bezer[10] demonstrated that injection of autologous brain can induce allergic encephalomyelitis in monkeys. The present work indicates that complement-fixing antibodies induced in rats by nervous tissue-adjuvant can react *in vitro* with autologous brain.

Each of 22 adult Wistar rats received 0·7 ml. of guinea pig spinal cord homogenate in Freund's complete adjuvant, distributed equally among seven intracutaneous sites over the dorsum and ventral neck. The animals were observed daily for clinical signs of encephalomyelitis (for example, hindleg paralysis) for 21 or 25 days. They were then killed by cardiac puncture to obtain sera for complement-fixing tests. At this time, one half of each rat brain was used for preparation of autologous rat brain antigen. The remaining brain and spinal cord of each animal were used for histological studies. Each rat serum was tested for complement-fixing antibodies against autologous brain and homologous brain and kidney antigens. The complement-fixing technique employed and the method of preparing ethanol extracts of these tissues for use as antigens differed from those used previously[4,11] as follows: (*a*) the tissues were not lyophilized prior to extraction with absolute ethanol; (*b*) the complement-fixing reaction mixtures, containing five 50 per cent hæmolytic units of complement, were held at 4–6° C. for 18 hr. before addition of the hæmolytic system.

Fourteen of 22 sera tested (Table 1) fixed complement with autologous brain. Eleven of these 14 sera also fixed complement with homologous brain. None of the remaining 8 of the 22 sera tested fixed appreciable amounts of complement with either autologous or homologous brain. Past work in our laboratory indicated that such complement-fixing antibodies are not present in sera of normal rats or in sera of rats injected with guinea pig kidney-adjuvant[12]. Those sera tested against homologous kidney were negative.

Table 1. Complement-fixing (CF) Antibodies in Sera of Rats after Injection of Guinea Pig Spinal Cord in Freund's Adjuvant

Rat No.	CF antibody titre of sera against indicated antigen*		
	Autologous brain	Homologous brain	Homologous kidney
*D*321	8†	8	< 4
*D*322	16	32	< 4
*D*325	32	32	< 4
*D*331	4	4	< 4
*D*333	16	8	< 4
*D*334	16	< 4	ND‡
*D*335	8	8	< 4
*D*385	8	4	ND
*D*387	4	< 4	ND
*D*388	8	4	ND
*D*390	8	4	ND
*D*392	8	4	ND
*D*394	8	4	ND
*D*396	4	< 4	ND

* Sera tested in dilutions of 1-4 to 1-128 against 1 : 25 dilution of brain and kidney antigens.

† Reciprocal of greatest dilution of serum giving maximum fixation of complement.

‡ ND, not done.

As expected from previous work[4–6,12], no direct correlation existed between the occurrence of allergic encephalomyelitis and the presence of the complement-fixing antibodies detected here against either autologous or homologous brain in individual rats. Ten of 14 rats, the sera of which reacted with autologous brain, had clinical signs and/or lesions of allergic encephalomyelitis. Five of 8 rats, the sera of which did not react with autologous brain, developed disease.

Our results (Table 1) indicate that injection of rats with heterologous spinal cord may induce complement-fixing antibodies which react *in vitro* with autologous nervous tissue.

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Tyrosyluria in Human Subjects

Tyrosyluria, that is, an abnormal excretion of aromatic metabolites of tyrosine, has long been known to occur in human subjects in ascorbic acid deficiency, particularly after a high tyrosine diet; it is readily abolished by feeding ascorbic acid. Recently, however, Bloxam *et al.*[1] have reported fairly rare cases of a tyrosyluria in apparently normal infants which did not seem to result from ascorbic acid-deficiency and which disappeared spontaneously with time.

We find this observation particularly interesting, since we believe that other cases of tyrosyluria, detectable by chromatographic methods though probably mostly within the normal range of less-specific analyses, occur frequently in ill subjects. We have previously described an increased excretion of some tyrosine derivatives in stress[2], and have now often observed similar phenomena in pathological urines of many types, from subjects not obviously suffering from lack of dietary ascorbic acid or from liver damage.

In many of these subjects, as with those of other workers, the characteristic compounds excreted in abnormal quantity are *p*-hydroxyphenyl-pyruvic and -lactic acids. Both substances are probably invariable minor constituents of normal human urine: the pyruvic acid has always been detected (as *p*-hydroxybenzalhydantoin) in extracts of acid-hydrolysed urine[3] and is presumably accompanied by trace amounts of the lactic acid, its reduction product. However, using extracts of urine equivalent to 1-min. excretion prepared by the method of Hill *et al.*[4] and chromatographed in *iso*propanol–ammonia followed by *n*-butanol–pyridine–water (70 : 10 : 20), we have but rarely detected (diazotized sulphanilic acid) *p*-hydroxyphenyllactic acid in healthy male British subjects, mostly young Royal Air Force personnel. It may be noted, however, that Armstrong *et al.*[5] reported it as being one of the more common constituents in their normal urines. Though this difference from our observations may well be accountable in terms of technique, diet and a less-restricted age-group of subjects, at least one other factor is of interest—the altitude (5,000 ft.) of the Salt Lake City laboratories of Armstrong and his group. Tyrosine metabolism is so linked with that of ascorbic acid that possible changes in the latter as a result of anoxia[6] leaves some ground for speculation.

Bloxam *et al.*[1] noted that the urines they examined contained *p*-hydroxyphenylacetic acid, while Boscott and Cooke[7] examined a group of subjects who rarely excreted *p*-hydroxyphenyllactic acid, but in whom the major tyrosine metabolite appeared to be *p*-hydroxyphenylacetic acid. The technique employed by the latter workers is open to some criticism, while the former did not comment on the excretion of the acetic acid by infants in general and made no claims regarding its significance. Further difficulties in interpreting this latter arise, since the acetic acid might originate from tyrosine via tyramine or via *p*-hydroxyphenylpyruvic acid, either metabolically or by decomposition in urine. At least in rats, recent work[8] has shown that it does not appear to be dependent on intestinal micro-organisms. We find *p*-hydroxyphenylacetic acid to be invariably detectable in normal urine (cf. ref. 5). Occasionally it has been detected in usually large quantity, but, with the exception of one subject who excreted it consistently thus, such occasions appear to be atypical of the subjects. In contrast, high rates of excretion have often been noted in both stress and other pathological conditions, not necessarily in subjects also excreting *p*-hydroxyphenyllactic acid. It seems necessary to consider the possibility that two distinct types of tyrosyluria do in fact exist.

Yet other tyrosine derivatives are sometimes present in large quantity in pathological urines: *p*-hydroxyphenylpropionic acid has only occasionally been noted; *p*-hydroxybenzoic acid is unfortunately certainly only derived in part from tyrosine; tyramine may be intimately connected with *p*-hydroxyphenylacetic acid; the compound recently identified with *p*-sympatol[9] may, by reason of its known physiological activity and unusual structure, be more than a mere by-product of tyrosine degradation. Another type of hydroxyphenyluria is characterized by the excretion of a group of unidentified phenols, sometimes in such relatively large amounts that it is difficult to account for them except in terms of tyrosine metabolism (the possibility of an origin from drugs has been excluded). Failure to react with 2 : 6-dichloroquinonechloroimide indicates the presence of the appropriate *p*-hydroxy grouping, while ease of oxidation suggests a possible second oxygen substituent (perhaps a conjugated hydroxyl group)

in the benzene nucleus. It is of interest that Bloxam *et al.*[1] detected an unknown phenol, while Boscott and Cooke[7] more specifically stated that their subjects excreted large quantities of polyphenols, including catechol. Further, in the single classical case of 'tyrosinosis'[10] the subject excreted, besides *p*-hydroxyphenyl-lactic and -pyruvic acids, a third compound identified as 3 : 4-dihydroxyphenylalanine, though unfortunately only on the basis of its properties and a carbon–hydrogen analysis. Normally degradation of tyrosine proceeds through a 2 : 5-dihydroxyphenol, homogentisic acid.

The term tyrosyluria may cover a number of abnormalities : how each may best be characterized is at present problematical. It seems likely that the development of accurate quantitative analyses for many urinary phenols will be essential for further progress.

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RADIOBIOLOGY

Strontium-90 in Human Plasma

The average daily dietary intake of strontium-90 in Britain during 1958 has been assessed as about 6 μμc. per gm. calcium[1]. It is well known that discrimination against strontium relative to calcium takes place in absorption from the gut and excretion by the kidney[2]. The combined effect of these discriminatory processes would lead to an expected concentration of strontium-90 relative to calcium in human plasma of about one-quarter that in the diet, that is, about 1·5 μμc. strontium per gm. calcium in 1958. No measurements of the strontium-90 content of human plasma have yet been reported. On the basis of the above estimation, at least 20 litres would be required for a measurable activity to be obtained. Thus the same individual must be bled on a large number of occasions over a long period of time or many individuals must be bled to provide a bulked specimen.

The Blood Products Laboratory, Lister Institute, provided us with 70 bottles containing about 120 litres of pooled plasma unfit for transfusion because of bacterial contamination. This had been prepared from whole blood collected between November 1958 and March 1959, except for about 2 litres dating from mid-1958. The consignment was divided into two parts : (1) South London, Birmingham, Bristol, Cambridge, Cardiff, Leeds and Belfast ; (2) Liverpool, Manchester, Newcastle, Sheffield and the north-east Metropolitan area. The strontium-90 content per gm. calcium in these two bulked plasmas has been determined. The results are taken to be representative of an adult population at the end of 1958.

Strontium together with calcium was precipitated in each bottle of plasma by the addition of a known excess of saturated oxalic acid. The solids were separated by centrifuging, bulked and thermally ashed at about 400° C.

The calcium content of each of the two batches was determined on a weighed aliquot by the standard oxalate – permanganate method. Strontium was separated from the large excess of calcium in the resulting ash by successive precipitations of strontium nitrate in 78–80 per cent nitric acid. The strontium-90 content was determined by separating chemically the daughter product, yttrium-90, after radioactive equilibrium had been re-established. The radioactive decay of yttrium-90 (half-life, 64 hr.) was followed over about eight days using an anti-coincidence counter. After correction for chemical loss (about 40 per cent) and self-absorption (5–10 per cent) the final results obtained were 1·1 and 1·4 μμc. strontium-90 per gm. calcium in the two batches. The estimated error in each observation was 25 per cent, so that no significance is attached to the difference between the two results. The observed concentrations of strontium-90 in plasma are thus consistent with a daily dietary intake of 6 μμc. per gm. calcium.

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Strontium-90 and Cæsium-137 in Grass and Milk in Finland during 1959

Milk and milk products are the main source of calcium (85 per cent of the total) in the average Finnish diet. As they are also important links in the transfer of radionuclides from atmospheric fall-out to the human body, we have started an investigation to determine the contents of some important radionuclides in Finnish milk. Results of determinations of strontium-90 and cæsium-137 for the year 1959 are reported here.

Two sets of samples were collected. 'Local' samples (Nos. 1–9, Table 1) were taken during the period August 29–September 6, 1959, on nine experimental farms between latitudes 60–69° N. and longitudes 23–27° E., where soil conditions, fertilizer practices and other agricultural factors are known in detail. 'General' samples (Nos. 10–15), analysed for strontium-90 only, were taken between May 1 and November 17, 1959, from one-day's milk intake (60–80,000 litres) of two milk-powder factories of the Kuivamaito Oy, located in south-east (*A*) and south-west (*B*) Finland. Both factories collect milk from more than ten dairies within a radius of 100 km. between latitudes 60° and 62° N.

Representative samples of grass were also collected from the experimental farms for analysis and determination of the discrimination factors for grass and milk of strontium-90 and cæsium-137.

Table 1. Calcium, Strontium-90 and Cæsium-137 Contents of Grass and Milk Samples from Finland (Mean Values of Duplicate Determinations)

Sample No.	Origin	N. Lat.	Date (1959)	Calcium/gm. ash		μμc. Strontium-90/gm. ash		μμc. Strontium-90/kgm. dry weight		μμc. Strontium-90/gm. calcium*		μμc. Cæsium-137/gm. potassium†	
				Grass	Milk	Grass	Milk	Grass	Milk	Grass	Milk	Grass	Milk
				Experimental farms :									
1	Apukka	66°	Aug. 29	7·46	16·5	7·19	0·61	632	35·2	96	3·7	87	60
2	Viik	60°	Aug. 29	6·54	15·5	5·77	1·00	594	55·4	89	6·7	220	43
3	Malminkartano	60°	Aug. 31	5·89	17·5	7·45	0·79	690	45·0	126	4·5	98	37
$4_{,1}$	Halola	63°	Sept. 1	4·21	16·2	5·21	0·67	517	35·3	122	4·2	—	
$4_{,2}$	Halola	63°	Sept. 1	6·39		5·75		570		92		—	21
5	Jokioinen	61°	Aug. 30	7·85	14·3	6·43	0·52	528	30·0	82	3·6	86	21
6	Anttila	60°	Aug. 31	6·59	16·0·	5·09	0·78	635	43·7	77	4·9	290	25
$7_{,1}$	Kreuksela	65°	Sept. 2	4·23	16·8	5·77	1·12	704	61·6	138	6·6	210	51
$7_{,2}$	Kreuksela	65°	Sept. 2	4·78		5·90		661		123		190	
8	Myttäälä	61°	Aug. 29	3·74	16·6	6·61	0·98	609	53·3	177	5·9	100	19
9	Toivonniemi	60°	Sept. 6	9·28	17·3	20·83	2·01	1,581	96·5	224	11·6	1,100	220
				Milk-powder factories :									
10	Kuivamaito Oy. *A*	60–61°	May 1		16·5		1·61		118		9·8		
11	Kuivamaito Oy. *A*	60–61°	June 23		16·8		1·63		125		9·7		
12	Kuivamaito Oy. *A*	60–61°	Aug. 15		16·4		1·31		96·3		8·0		
13	Kuivamaito Oy. *A*	60–61°	Nov. 17		17·4		1·47		118		8·4		
14	Kuivamaito Oy. *B*	60–61°	May 30		17·1		1·36		106		7·9		
15	Kuivamaito Oy. *B*	60–61°	June 1		16·5		1·41		109		8·6		

* The error due to counting (two standard deviations) is < 14 per cent.
† Standard deviation less than 20 per cent.

Radiostrontium was isolated by the method of Bryant *et al.*[1] and β-activity was determined with a low-background counter *CE*-14 manufactured by Tracerlab.

Cæsium-137 was determined γ-spectrometrically in milk and grass ash prepared below 450° C. in the manner described, for example, by Löw and Edvarson[2] and by Lillegraven[3]. The shielding system and pulse height analyser used in this work have been described by Vuorinen[4]. The cæsium-137 activity of the milk-ash samples was calculated after correction for background and potassium counts.

Determination of cæsium-137 in the grass-ash samples was only possible after an estimation of the relative amount of zirconium-95 + niobium-95 in the spectrum (Fig. 1) by using the channels outside the maximum of the cæsium photopeak (region I in Fig. 1). A correction for zirconium-95 + niobium-95 pulses in the cæsium-137 channels, in addition to the background and potassium-40 pulses, thus became possible.

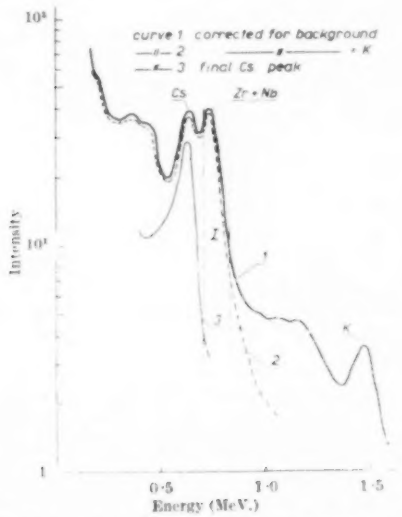

Fig. 1. Differential pulse-height spectrum of the grass sample No. 9

The results are presented in Table 1. They show that the strontium-90 and cæsium-137 contents of milk in Finland do not differ essentially from that of the milk of other countries in corresponding climatic conditions[5,6]. The discrimination factor for grass and milk, that is, the ratio μμc. strontium-90/gm. calcium in milk divided by this ratio for grass, is about 0·048. The corresponding factor for cæsium-137 is 0·28.

The ratio μμc. cæsium-137/gm. potassium per μμc. strontium-90/gm. calcium for grass is 1·95 : in milk the mean for the samples from south and middle Finland (Nos. 2–8) is 5·66. The values of the two Lapland samples, however, are significantly higher, namely, the sample from Apukka (No. 1) 16·2 and that from Toivonniemi (No. 9) 19·0.

More detailed reports on this investigation will appear elsewhere.

We are greatly indebted to the Finnish Atomic Energy Commission for financial aid, to Prof. Jouko Vuorinen of the Agricultural Research Centre for advice and help, to Mr. R. Arasjärvi, and the Kuivamaito Oy for spray-drying the milk samples and to the Food and Agriculture Organization for an André Mayer Fellowship to one of us (J. K. M.).

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Glutamic Acid Metabolism in Brain and Liver during Infusion with Ammonia labelled with Nitrogen-15

RECENT results of *in vivo* experiments using glutamic acid labelled with carbon-14 were consistent with the hypothesis that the amidation of the administered amino-acid to glutamine represents a metabolic event occurring in a tissue or cellular compartment[1,2]. Since glutamic acid and glutamine syntheses in the central nervous system are the two known processes by which ammonia enters organic linkage, it appeared of great interest to approach the question of setting into compartments the metabolism of glutamic acid and its derivatives with the aid of ammonia labelled with nitrogen-15.

^{15}N-ammonium acetate was infused into the carotid artery of cats over a period of 8–85 min. with simultaneous electroencephalographic and electrocardiographic tracings. The experiments were terminated by exsanguination of the animal, the blood was collected, brain and liver excised and frozen, and the level of glutamic acid and its metabolic derivatives determined in the tissue samples[2,3] as well as the concentration of nitrogen-15 in the amino or amide groups respectively of these compounds. The results of a typical experiment of 25-min. duration are given in Table 1.

Table 1. ISOTOPIC CONCENTRATION IN GLUTAMIC ACID AND RELATED METABOLITES AFTER NITROGEN-15 LABELLED AMMONIA INFUSION INTO THE CAT

	Blood		Brain cortex		Liver	
	μM/gm. tissue	N-15 Atom per cent excess	μM/gm. tissue	N-15 Atom per cent excess	μM/gm. tissue	N-15 Atom per cent excess
Ammonia	2·8	81·9	1·8	65·7	4·6	42·6
Glutamine amide	0·32	21·4	7·8	38·7	0·83	28·7
Glutamine α-amino	0·32	1·8	7·8	8·6	0·83	5·4
Glutamic acid	0·08	3·1	9·3	0·87	1·6	13·6

Nitrogen-15 ammonium acetate (99·6 atom per cent excess) 1 m M/ml. infused into carotid artery of a succinylcholine paralysed 3·3 kgm. cat at a uniform rate for 24 min. (total dose, 16 m.moles). Experiment terminated at 25 min. by bleeding from the carotid artery; cortex and liver frozen *in situ* with solid carbon dioxide.

While the concentrations of the amino-acids measured in the various tissues remained constant or decreased slightly, the level of glutamine in the brain increased by at least 50 per cent (for normal values see ref. 4). The observation that the nitrogen-15 content of the amide group of cerebral glutamine is higher than that of liver or blood indicates that this amide is synthesized in the brain. Since the level of glutamine in brain increased considerably, the high specific activity of the amide group is probably not due to an exchange with free ammonia but to a net synthesis of glutamine. Circumstantial evidence for glutamine synthesis in the brain has come from experiments on hepatectomized animals[5] and is consistent with the high synthetase activity in this organ[6,7].

Of particular interest is a comparison of the concentration of nitrogen-15 in the α-amino group of glutamic acid and of glutamine isolated from the brain. Since the α-amino group of glutamine has ten times the specific activity found in glutamic acid, brain glutamine must be derived from a compartment of glutamic acid which is not in equilibrium with the total tissue content of this acid unless glutamine is synthesized appreciably by a pathway which does not require glutamic acid as the immediate precursor.

In contrast to the observations on brain, the α-amino group of liver glutamine is of lower specific activity than that of liver glutamic acid, a result which might be expected if the glutamic acid used for glutamine synthesis in the liver mixes rapidly with the total tissue pool of this amino-acid. However, in preliminary double-labelling experiments (^{14}C glutamic acid and $^{15}NH_3$) compartmentalization of glutamic acid used for glutamine synthesis can also be demonstrated in this organ in the presence of high ammonia concentrations.

If glutamic acid is utilized for the synthesis of the additional glutamine in the brain, the former amino-acid is apparently made in this organ and not derived from the blood, since the nitrogen-15 content of the α-amino group of brain glutamine (8·6 per cent) is higher than that of blood glutamic acid (3·1 per cent).

According to present evidence the reductive amination of keto-glutaric acid occurs in the mitochondria[8] while glutamine synthetase is localized in microsomes and mitochondria[9]. Further experiments will have to show whether the results of this and previous work together with evidence for the enzyme distribution in the cell are indicative of different metabolic pools within the cells for the metabolism of administered glutamic acid and of that synthesized in the tissue. This type of investigation may point the way by which the problem of setting into compartments of metabolic events *in vivo* may be approached[10]. A detailed account of the experiments as well as of the effects of ammonia infusion will be given elsewhere.

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Alpha-Activity of Wheat and Flour

IN their work on naturally occurring radioactivity in man and his environment, Mayneord and his co-workers have indicated[1,2] the wide range of alpha-radioactivity found in the more common foodstuffs. Using the same experimental method, we have recently made measurements on a number of samples of wheat and wheat products of known origin, and

wish in this communication to report briefly on three aspects of our findings.

Using wheat from the United Kingdom, Canada, New Zealand, Victoria, South Australia and Western Australia, we have noticed that, while there are typical differences between wheats from these sources, with wheat from any one source there appears to be a connexion between alpha-activity and soil *p*H. As an example, we are indebted to the National Institute of Agricultural Botany for a series of samples of wheat varieties grown together, in trial, at nine different centres. A relatively small range in activity occurs between varieties, but as between locations we found these limiting cases: variety Cappelle Desprez grown on chalk soil at Sparsholt in Hampshire had an activity of 0·21 μμc./gm. ash, soil *p*H 7·8; the same variety grown on an acid loam at Winnarleigh in Lancashire had an activity of 1·66 μμc./gm. ash, soil *p*H 5·2. This ratio of 8 : 1 contrasts with that of only 2·5 : 1 for variety; the highest activity found at Sparsholt occurred in the variety Dominator, which was measured as 0·49 μμc./gm. ash. This effect of soil *p*H was also found in all foreign wheats when variety samples were compared.

With milled wheat we have compared the activities of bran and white flour with the wheat from which they were derived. The mean of six samples in each case was: wheat, 1·1 μμc./gm. ash; bran, 1·0 μμc./gm. ash; flour, 1·0 μμc./gm. ash.

It would thus appear that the alpha-activity of wheat is of soil origin, in contrast to the occurrence of strontium-90, in which the much higher content in bran as compared with flour has been interpreted[2] as due to retention of air- or rain-borne material in the developing ear of the plant.

In wheat from widely separated sources we have observed a considerable range in alpha-activity:

Source of wheat	Samples tested	Mean activity (μμc./gm. ash)
United Kingdom	30	1·0
Canada	15	1·0
New Zealand	30	2·5
Victoria	15	2·5
South Australia	2	2·6
Western Australia (Fremantle)	3	25·0

In respect of the high figures for Western Australian wheat, consistently high activities were obtained from three different shipments of this grain. The ratios of activity from thorium and radium families were similar in all cases, averaging 30 per cent.

Finally, we would mention that these results might be better expressed in terms of the calcium with which they are associated. Wheat ash (1·4–1·8 per cent of the dry weight) contains about 2·8 per cent of calcium, whereas in white flour the ash (0·5 per cent dry weight) contains nearly 4 per cent. Present legislation, however, makes it compulsory in the United Kingdom to add, as creta praeparata, 0·125 per cent of calcium to flour (except to wholemeal), thus increasing its content of calcium to 0·145 per cent.

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BIOLOGY

Use of Gibberellin to hasten Germination of *Solanum* Seed

True seed of the potato (*Solanum tuberosum* L.) frequently has a delayed germination[1], and we find that this also applies to most other tuber-bearing *Solanum* species, where it is usual for seed to remain dormant from 1–3 months or longer. Geneticists and potato breeders have been inconvenienced by this difficulty. Our results with certain techniques[2,3] for hastening germination of *Solanum* seed have been variable. Since gibberellin has been used to promote germination and terminate dormancy of seeds in other genera[4–6], its effectiveness to hasten germination of *Solanum* seed was investigated by us.

In preliminary tests, gibberellin concentrations of up to 100 p.p.m. had little effect on breaking dormancy of recently harvested *Solanum* seed, but germination was stimulated by concentrations of 1,000–4,000 p.p.m. To confirm this result, dry seeds of several *Solanum* species and species hybrids were examined microscopically with transmitted light to select those containing mature embryos. Lots of 50 seed were soaked for 24 hr. in different concentrations of the potassium salt of gibberellic acid (75 per cent actual). The seeds were then washed in three successive changes of distilled water and placed on moist blotting paper in Petri dishes kept at room temperature (20–30° C.). As controls, similar lots of seed were treated with distilled water but otherwise handled in the same manner. The results (Table 1) show per cent germination for gibberellin-treated seed.

Although prolonged exposure of the seeds to the 1,000 p.p.m. concentration increased per cent germination appreciably, treatment with 2,000 p.p.m. for

Table 1. Effect of Gibberellin on Germination of Recently Harvested *Solanum* Seed

Solanum species		Age of seed in days after harvest	Germination (per cent)*			
			Concentration of gibberellin (p.p.m.)			
			0	1,000	2,000	4,000
S. chacoense Bitt., clone *A*	*SC*†	3	52/60	—	90/96	92/100
S. chacoense Bitt., (clone *A*) × *S. commerae* Juz. et Buk.	—	17	14/18	—	60/84	78/94
S. demissum Lindl., clone	*S*‡	1	0/2	58/84	90/100	96/98
S. jamesii Torr.	*SC*†	7	0/0	—	36/40	—
S. pinnatisectum Dun. × *S. jamesii* Torr.	—	4	0/6	—	28/78	—
S. phureja Juz. et Buk., clone	*SC*†	2	50/74	—	98/98	—
S. stoloniferum Schlechtd., clone *A*	*S*	3	0/10	100/100	—	—
S. stoloniferum Schlechtd., clone *B*	*S*	1	0/0	—	32/100	—
S. trifidum Correll × *S. jamesii* Torr.	*S*	1	28/46	—	86/98	—
S. tuberosum L., variety Hunkuil	*OP*§	3	0/8	4/58	—	—
S. tuberosum L., variety Hunkuil	*OP*	60	4/38	40/84	60/96	38/94
S. tuberosum L., variety Katahdin	*S*	14	8/10	—	96/98	—
S. tuberosum L., *F* 4792	*OP*	60	26/68	100/100	98/98	96/96
S. verrucosum Schlechtd.	*SC*†	7	0/0	—	0/46	—

* Fifty seeds were soaked in the gibberellin solutions for 24 hr. Numerator is the percentage of germination in 15 days, denominator is that in 30 days.
† Sibling cross.
‡ Selfed.
§ Open pollinated.

24 hr. gave optimum germination. The 4,000 p.p.m. concentration was no more effective than the 2,000 p.p.m. concentration. At the optimum concentration the majority of treated seeds had germinated in 15 days. The gibberellin treatment accelerated germination in seeds which had little dormancy and in seeds approaching the end of their dormancy period. Seeds of *S. demissum* Lindl., U.S.D.A., *P.I.* 160227 and of a *S. chacoense* Bitt. × *S. phureja* Juz. et Buk. derivative exhibited no dormancy. Similarly, Odland[7] reported immediate germination in a number of seed lots of *S. tuberosum*.

Plants were grown to maturity from the gibberellin-treated seeds, and in all cases growth was normal. The above method has been used in our work with *Solanum* species and allows us to grow many more plant generations in a given period of time.

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Pollen Germination in Some Gramineae

I. K. Vasil, in his communication under this title in *Nature* of September 24, p. 1135, states that "this is the first report of a successful germination of the pollen of Gramineae *in vitro*". May I point out that the germination of pollen of different varieties of *Saccharum officinarum* was carried out as a routine practice by the Sugarcane Research Station in Mauritius as far back as 1930. The methods used are described by Glendon Hill[1] and de Sornay[2]. Germination tests were discontinued later, as it was found that there was poor correlation between germination of pollen *in vitro* and number of sugar cane seedlings afterwards produced[3].

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A Selective Medium for the Formation of Ascospores by *Aspergillus nidulans*

Little is known about the ascospore composition of the Ascomycetes, partly because of the difficulty of obtaining a massive production of such cells. During an investigation of the nutritional requirements of a strain of *Aspergillus nidulans* obtained from the Botany School Collection, Cambridge, observations were made that led to the recent development in this laboratory of a method for obtaining satisfactory yields of ascospores without interference from the conidiospores. This fact has enabled fractionation studies on *A. nidulans* ascospores to be undertaken, as well as other biochemical investigations which are now in progress.

Microscopically and culturally the strain used in these studies is similar to that described by Thom and Raper[1]. This organism, when cultured in Czapek's agar, produced colonies characterized by a dense vegetative mycelium spreading quickly on the agar, with abundant green conidial heads freely distributed on the surface of the colony, and relatively few perithecia scattered through the different areas of the colony; ascospore production lasted several weeks.

When the mould was cultured on a medium with the following composition: Urea or ammonium oxalate, 3 gm.; dipotassium hydrogen phosphate, 1 gm.; crystalline magnesium sulphate, 0·5 gm.; potassium chloride, 0·5 gm.; ferric sulphate, 0·05 gm.; sucrose, 30 gm.; agar-agar, 15 gm., and distilled water, 1,000 ml., colonies were formed with very different general morphology from those obtained on Czapek's medium. Under these conditions perithecia developed separately within or on the conidial layer with a dark reddish purple coloured envelope of scattered hyphae bearing a considerable number of Hulle cells. On ripening, these became a mass of eight-spored asci which broke down quickly, releasing the ascospores. When a preparation of this material was examined under the microscope an enormous number of purple-red lenticular ascospores, with two equatorial crests, were observed, with very few contaminating conidiospores.

Another characteristic was particularly marked when plates were viewed in reverse, namely, an intense purple pigmentation extended through all the medium marking the under-surface of perithecia and ascospores. This pigmentation was absent after growth on plain Czapek's agar.

We are indebted to Mr. J. Bean of the Botany School, University of Cambridge, for sending us a culture of this mould.

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Degeneration of Flight-musculature in the Corixidae and Notonectidae

Within the New Zealand species of the families Corixidae and Notonectidae (Hemiptera-Heteroptera), two distinct forms, depending on the development of the wings and the wing-musculature, have been recognized. In these species a proportion of the population is composed of flightless animals in which, apart from *Diaprepocoris zealandiae*, the indirect flight-musculature is reduced even though the two sets of wings are not significantly altered from the normal condition. In *D. zealandiae* the meta-wings are greatly reduced and the meso-wings differ in having a reduced membranous portion.

The differences in the musculature are obvious immediately the mesothoracic tergite is removed, for in place of the solid blocks of yellow fibre the flightless form contains either a pale white, loosely compacted

Particle Sizing by Sedimentation

THE Gallenkamp SEDIMENTATION BALANCE

with Automatic Recording

Photo by courtesy of Ferodo Ltd.

For particle size determination within the range 5 to 75 μ. If, however, the largest size is not greater than, say, 20 μ, the lower limit can be extended to about 2 μ provided the temperature is controlled within fairly narrow limits and agglomeration or flocculation does not take place.

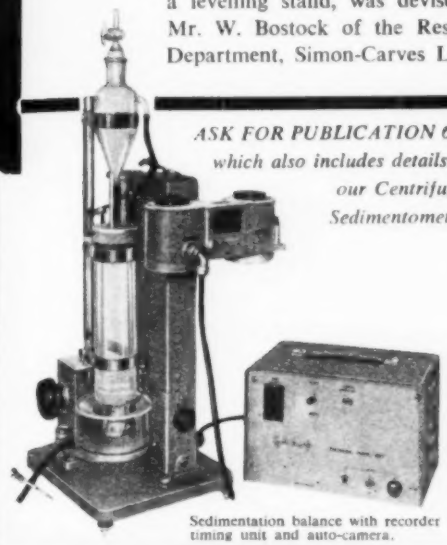
A wide variety of materials which have been examined includes alumina, carborundum, china-clay, cement, felspar, flint, flour, limestone, pyrites and plastics, and dusts collected by electrostatic precipitators and cyclones from boiler, blast furnace and flash roaster plants. This self-contained instrument, comprising a sedimentation system, receiving tank and a direct reading torsion balance, all mounted on a levelling stand, was devised by Mr. W. Bostock of the Research Department, Simon-Carves Ltd.

- **High reproducibility.**
- **Maximum sensitivity : full scale deflection for 0.5 g of powder of sp. gr. 1.5 in a liquid of sp. gr. 1.0.**
- **Saves time : Duration of test : 6 hours for full range 5 μ to 75 μ.**
- **Saves labour : Recording equipment : releases operator for other work.**
- **Easy operation. Simple maintenance.**
- **Balance sensitive yet robust : readings by an integral optical system.**

British Patent No. 712,434 and U.S. Patent Application No. 323,996.

NOTE : This apparatus is under consideration by the BSI for possible adoption as a British Standard.

ASK FOR PUBLICATION 615 which also includes details of our Centrifugal Sedimentometer.



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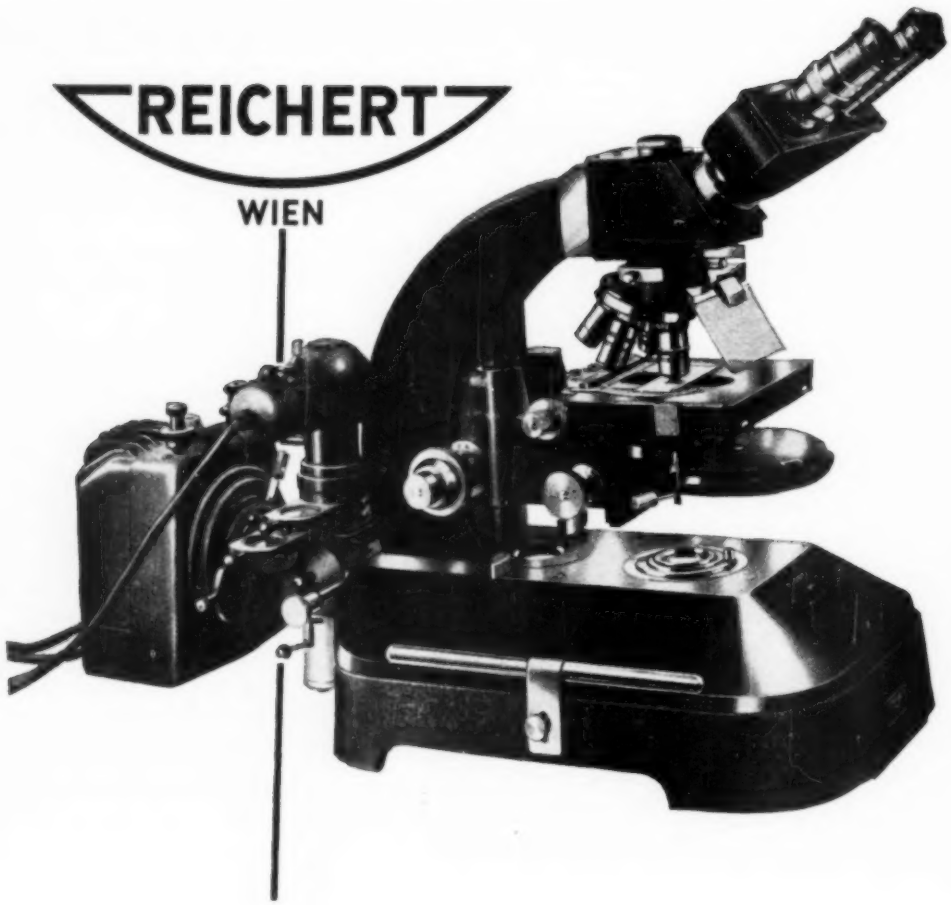

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fibrous mass, or, more usually, only parenchymatous tissue. There are a number of differences, too, in the form of the body and the extent of chitinization and pigmentation. Without recourse to dissection, the two forms may be readily distinguished. Flightless animals, besides being significantly smaller, are less pigmented, and the chitinization, particularly of the thorax, is greatly reduced.

Although the degree to which the flightless animal is modified from the normal condition varies throughout these species, within each of them the extent of the modification is remarkably uniform and no intermediate forms have been discovered. This uniformity applies not only to the condition of the musculature but also to the modifications already noted. This situation follows from the mechanism by which the condition is developed. Normal growth of the wing-musculature is not continued throughout the fifth instar, and at the conclusion of the moult to the imago the final modifications of the skeleton have been achieved, although the histolysis of the partly developed fibres and their replacement by parenchyma continues for a short period.

The factors responsible for the control of the development of the muscle-form reside in the environment, and until late fourth instar either form may be produced depending on the habitat conditions. A close association between the environmental conditions, with respect to stability of the habitat during drought, and the muscle-form developed in the population, results from delaying the critical period for this control until the fifth instar. Almost without exception, the less-stable habitats within the species range contain only animals with normal musculature. In stable areas—streams and lakes in which the population may be maintained throughout the year—both forms are found, but the population is predominantly of flightless individuals. Flying animals are necessary for the maintenance of populations in the unstable habitats of the species range; through migration they re-establish the species in habitats that have been dry during the summer.

From a comparison of the extent of the changes that are associated with the cessation of wing-muscle growth in the species of *Sigara* and in *D. zealandiae*, it is apparent that the loss of this musculature is an early stage in the process leading to the brachypterous condition: the wing-musculature is first reduced and only then are the meta-wings modified.

In the New Zealand fauna this condition of the musculature which gives rise to flightless animals without alteration of either pair of wings has been recognized in each of the seven species of *Sigara* (*Tropocorixa*) and in the two species of *Anisops*. With experience of the modifications resulting from the change in musculature, it is apparent from the accounts of these two families in other localities that this condition occurs in a number of other species. The two colour forms described by Brooks[1] in *Anisops* are due to this feature. *A. wakefieldi*, a species found in New Zealand, is considered in this work and the two forms dependent on the condition of the musculature are described, although no explanation is offered to account for them. The numerous brachypterous forms recorded in the species considered by Hungerford[2] and Poisson[3] suggest that many other species in which the musculature only is reduced probably occur also. Finally, Brown[4] attributes the anomalies noticed between the abundance and migration-rate in a series of British Corixidae to physiological factors. It seems more likely that, as the species in which the relation was least satisfactory were associated with stable habitats, this was a consequence of the reduction of the flight musculature in these animals.

A fuller account of this work is being published elsewhere.

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Environment and Reproduction in Freshwater Triclads

Reproduction in triclads varies from asexual to complicated sexual methods[1,2] both within and between species. Attempts to determine the causes of such differences resulted in controversy between students favouring the external environment[3] and those favouring an internal physiological process[4,5] as the determinant.

Dahm's[2] researches on triclads inhabiting running water, coupled with work[6,7] on the triclads of standing water, suggest a broad relationship between habitat and mode of reproduction. When triclad species are arranged in a series based on increasing productivity of the habitat (*sensu* Ruttner[8]), often accompanied by higher average temperatures, it extends from *Phagocata vitta*, which is found in the harshest conditions inhabiting moorland streams and upland lakes, to *Dugesia lugubris*, which is found only in the most productive lakes and quieter reaches of some lowland rivers. Table 1 shows such a series for the commoner freshwater triclads of northern Europe

Table 1. North European species arranged in order of productivity of their habitats, showing prevalent types of reproduction

Species	Habitat		Reproduction			Cocoons
	Lotic	Lentic	Asexual only	Both	Sexual only	
Increasing productivity →						
Phagocata vitta (Duges)	X		+ + +	+	+	Winter
Crenobia alpina (Dana)	X		+ + +	+ +	+	Winter
Polycelis felina (Dalyell)	X		+ + +	+	+	Winter
Dugesia gonocephala (Duges)	X		+	+	+ + +	—
P. nigra (Müll.)	X	X		+	+ + +	Early spring
P. hepta (E. H. and Y. Melander)		X			+ + +	Spring
P. tenuis (Ijima)		X			+ + +	Spring
Dugesia lugubris (Schmidt)		X			+ + +	Early summer
Dendrocoelum lacteum (Müll.)		X			+ + +	?

together with the mode of reproduction and the season of sexual reproduction.

Asexual reproduction is the usual means of population increase in species occupying unproductive habitats, and it becomes progressively less important and is finally replaced altogether by the sexual process in species found in the most productive habitats. This is also accompanied by a change in the season at which the sexual process occurs. Thus, in *Phagocata vitta* and *Crenobia alpina*, and to a lesser degree in *Polycelis felina*, sexual reproduction occurs mainly in winter in North European populations. *Polycelis nigra* starts to breed in the early spring[9], *P. tenuis* and *P. hepta* slightly later, while *D. lugubris* does not begin until the late spring or early summer[10].

Dahm showed that growth and reproduction of species living in unproductive streams are possible only when the basic metabolism is slowed down by low temperatures characteristic of winter conditions; this applied over a range of feeding regimes. In species such as *P. tenuis* which live in lakes of intermediate productivity I have found that, while winter temperatures inhibit breeding, it occurs at temperatures characteristic of the British spring and summer. Breeding in *D. lugubris* is rather more sensitive to low temperatures and rather less to high temperatures. In both species breeding ceases when they are kept at temperatures higher than those of an average summer (about 24° C.), and this is followed by retrogression of the reproductive organs and a decline in size despite a plentiful supply of food. Such a relationship between energy intake and expenditure might explain the infrequency of sexual reproduction in species occupying unproductive habitats and its restriction to colder periods. Under such conditions food would never be plentiful, but would be particularly scarce when low temperature would favour the channelling of energy into growth and ultimately reproduction. Sexual reproduction therefore might be so restricted that without other means of multiplication many populations would become extinct. The existence of asexual methods of reproduction in such species as *Ph. vitta*, *C. alpina* and *P. felina* solves this problem. The tendency to breed in winter suggests that high temperature is more important than scarcity of food in preventing sexual reproduction under natural conditions in northern Europe. In contrast, sexual reproduction in species living in productive habitats would be possible each year when abundance of food (relative to activity), permitted growth and reproduction in a proportion of the population. In these circumstances sexual reproduction, which is regarded as conferring advantages from an evolutionary point of view, would be more common.

Clearly, apart from the basic differences in the ability of the several species to function at various temperatures, any differential effect of temperature might emphasize the contrasts outlined above between the triclads of unproductive and productive habitats. From the available data[11,12] such a differential appears to be present, and species like *C. alpina* and *P. felina* not only have a higher basic level of activity but also are unable to control their activity when the temperature is increased as, for example, *Dugesia gonocephala* can.

It is interesting to note that Dahm also found that within a single species there were populations which could only reproduce asexually (usually polyploids with odd multiples of the haploid chromosome number), some which could multiply both sexually and asexually, and others which showed only sexual reproduction. It would be rewarding to study the ecology of such populations to determine the relationship between the habitat and mode of reproduction.

If it is assumed that the primitive triclad reproduced by both methods, then it appears that selection has operated to suppress sexual reproduction in the species of unproductive habitats and asexual reproduction in those of productive habitats.

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A Possible Method of Sex Ratio Determination in the Parasitic Hymenopteran *Nasonia vitripennis*

Nasonia vitripennis (Walter) (Pteromalidae) is parasitic on the pupal stage of muscoid flies. The female drills through the host puparium and lays eggs on the pupa within. When a population of *N. vitripennis* has ready access to host puparia, each generation of the offspring is composed of females and males in the ratio 3 : 1[1]. The females are diploid and the males haploid[2]. So far, no suggestion has been made as to how this sex ratio may be determined; but it seems possible that it may be affected by the arrangement of the eggs in the ovariole before fertilization. The eggs are shaped like curved sausages and are more pointed at one end than the other. This is the typical hymenopterous shape. Owing to its curvature, each egg has in its meridional plane a convex and concave side. Within each ovariole the eggs are orientated so that the oldest eggs, namely those nearest the oviduct end of each of the four ovarioles which comprise a single ovary, almost always have their convex aspect pointing away from the axis of the ovary as a whole (Fig. 1). This arrangement was observed in 46 out of 50 insects examined.

The chorion of the egg is rigid compared with the very thin walls of the vagina and oviduct, and it is a reasonable assumption that the eggs either maintain their orientation or twist in a more or less constant manner as they leave the ovariole and pass one at a time through the short oviduct into the vagina. If either of these suppositions were true, the eggs from adjacent ovarioles would lie in the vagina successively so that their concave aspects make an angle of 90° to each other. All the eggs from any one ovariole should generally be orientated the same way when they arrive in the vagina.

In the vagina, the eggs come into contact with a muscular tongue which projects into the vagina from

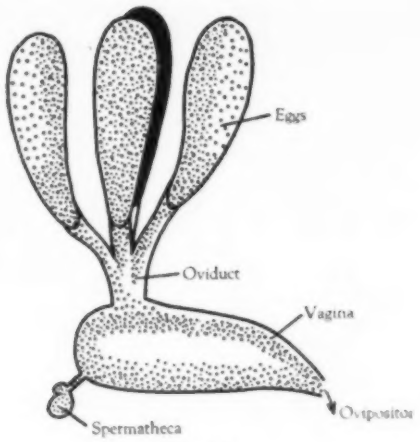

Fig. 1

its dorsal surface (Fig. 2). Flanders[4] described a similar tongue in *Nemeritis canescens* (Grav.) and suggested that it might press the micropyle of the egg against the spermathecal duct, which opens on the postero-ventral surface of the vagina in the mid-line. In this way the chances of fertilization would be improved. It seems possible that the vaginal tongue of *Nasonia vitripennis* functions in a similar way. From Fig. 2 (*b*, *c*) it can be seen that, when an egg's concave face is either dorsally or laterally orientated in the vagina, the tongue could press the egg's micropyle against the opening of the spermathecal duct; when the meridian of the egg is ventral as in Fig. 2 (*a*), however, the tongue would force the micropyle away from the duct of the spermatheca so that the sperm could not enter the egg. Therefore, on average one-quarter of the eggs laid would not be fertilized and so produce males. This suggests that all the eggs from one of the ovarioles may not be fertilized, and it accounts for the observed sex ratio of 21 per cent males in populations which had free access to host puparia[1].

When mated females are deprived of host pupæ for four days prior to oviposition, the proportion of males in the offspring increases to 38·9 per cent[1]. It is known that if eggs are not laid within two days of their reaching maturity a process of resorption begins. Until now it has been suggested that in many Hymenoptera a partially resorbed egg produces a female because it is in the ovary longer and so stands a better chance of being fertilized[4]. On the present hypothesis, an alternative explanation would be that the tongue cannot push the partially resorbed egg's micropyle against the spermathecal duct because the egg has lost its shape and rigidity, Fig. 2 (*d*). The egg is therefore not fertilized and produces a haploid male.

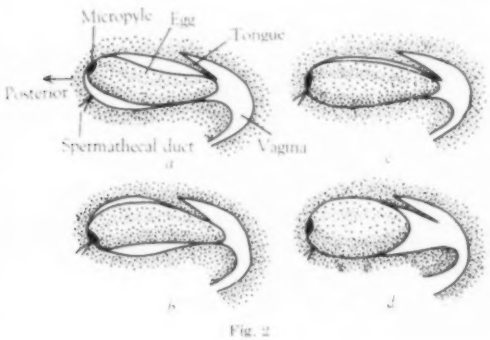

Fig. 2

I am grateful to the University of Hull and the Ministry of Education for financing this research, to Prof. P. G. 'Espinasse in whose Department the work was done, and to Dr. J. H. Sudd for help and criticism.

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Occurrence of an Egg-String in *Enoplus communis* Bastian, 1865 (Nematoda : Enoplidae)

ADULT members of the phylum Nematomorpha, residing in aquatic habitats, lay their eggs within long strings commonly referred to as 'egg-strings'. In the nematomorphs this egg-string is considered a secretory product of the antrum (a common chamber situated between the uteri and the cloaca and lined with a layer of glandular epithelium)[1]. Whereas the egg-laying habits of the nematomorphs are fairly well described, those of marine nemas are practically unknown. Hyman[1], in the Nematoda section of her invertebrate compilation, states that some marine nemas lay their eggs in an adhesive mass. Recently, the opportunity to elaborate on this observation was presented while I was studying marine nemas at the Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

Fig. 1. 'Egg-string' of *Enoplus communis*

Live specimens of *Enoplus communis* Bastian, 1865, taken from the holdfasts of unidentified marine algae collected from Penzance Point at Woods Hole, were placed in a watch-glass in sea-water and left for 10–12 hr. Low-power examination of the specimens then revealed the presence of a line of 22 eggs. Higher magnification showed that each of the 22 eggs was contained within a continuous, transparent sheath (Fig. 1). In this respect the egg-containing sheath (egg-string) of *E. communis* appears to be analogous to that of the Nematomorpha. This sheath was attached to the bottom of the watch-glass, was adhesive, and contracted when probed with a

dissecting needle. Presumably, the sheath anchors the eggs in habitats where they might otherwise be carried away or washed ashore by tidal action or else be subject to predation if deposited freely.

The sheath was at first thought to have arisen from vaginal (or vulvar) glands. However, on examination of *E. communis* females *in toto* and in cross-section, glandular structures were not observed. Histological studies are being conducted in an attempt to determine whether glandular tissue, possibly epithelium analogous to that of the antrum of the Nematomorpha, is associated with the distal portions of the reproductive tract.

It was also noticed that, though eggs within adult females were unsegmented, those in the egg-string were segmented and at the 6- to 8-celled stage of development.

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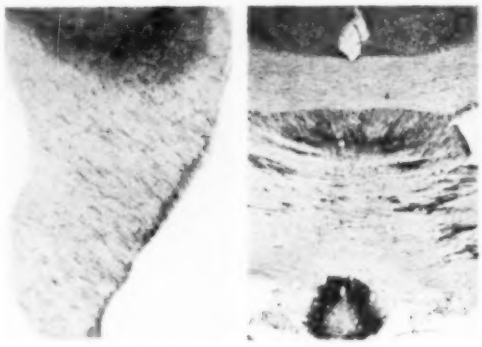
ANATOMY

Cholinergic Nervous Pathways in the Forebrain

In a previous communication[1] we described the use of a modified Koelle technique to produce selective staining of certain nuclei and tracts in the rat hindbrain. We have applied recently a similar method to the forebrain of normal animals and after transcortical lesions performed with an ophthalmic knife or cautery. The brains were removed after perfusion with 10 per cent formol saline, and 5–6 mm. transverse slices were afterwards fixed in the same fluid in the cold. To facilitate cutting, the tissue after fixation was soaked in 20 per cent alcohol, or embedded in an alginate gel according to a technique to be described elsewhere. The various media used for incubation contained either acetylthiocholine or butyrylthiocholine as substrates, with or without the addition of 10^{-4} *M* ethopropazine as a pseudocholinesterase inhibitor.

In sections of normal brains incubated with acetylthiocholine substrate, the forebrain tracts which stained selectively included the ventral supra-optic decussation, the central core of the fasciculus retroflexus, the cingulum, and the most lateral and most medial elements of the stria terminalis. In addition, stained fibres were interspersed in considerable numbers among the unstained fibres of the efferent projection pathways of the hippocampus: that is, in the alveus and in the dorsal fornix and fimbria behind the ventral hippocampal commissure. Caudally, most of the stained fibres of the dorsal fornix pierce the dorsal hippocampal commissure and so connect with the alveus, although some may connect with the cingulum via the corpus callosum. In the fimbria the stained fibres appear closely packed along its ventrolateral border (Fig. 1*a*). No fibres were seen in the descending columns of the fornix, and the crossed fibres of the ventral hippocampal commissure were likewise unstained. Below this commissure heavy staining due to true cholinesterase was rather unexpectedly found in the subfornical organ or intercolumnar tubercle (Fig. 1*b*), especially around its periphery, where a fine nervous plexus



(*a*) (*b*)

Fig. 1. *a*, Stained fibres of fimbria. Blood vessels also present, unstained in sections incubated with pseudocholinesterase inhibitor. *b*, Stained fibres of cingulum above corpus callosum, and of dorsal fornix between corpus callosum and ventral hippocampal commissure. Stained cells belonging to nucleus of ventral hippocampal commissure. Subfornical organ heavily stained below commissure

can be detected in sections stained by the Bodian silver method.

A high concentration of true cholinesterase within the axon, such as has been demonstrated in all the tracts mentioned above, is characteristic of cholinergic neurons[2]. Having observed in the hindbrain that the cell bodies of such neurons are themselves rich in enzyme and stain heavily by the Koelle method[2], we have attempted to trace some of these presumably cholinergic pathways of the forebrain to their nuclei of origin. The lateral fibres of the stria terminalis appear to run caudally from cells of the bed nucleus of that tract to the unstained area occupied by the central amygdaloid nucleus. The medial fibres associated with the stria terminalis, on the other hand, have no connexion with either the lateral amygdaloid nucleus or the nucleus of the lateral olfactory tract, which are the two stained nuclei of the amygdala, but appear to run forward from the ventral nucleus of the lateral geniculate body, and curve downwards and backwards in front of the reticular nucleus of the thalamus. Sagittal sections show some fibres of the cingulum arising from small, deeply stained cells of the nucleus of the diagonal band; others are probably derived from similar cells of the medial septal nucleus. These two nuclei are also a likely source for the stained fibres of the dorsal fornix and fimbria, although there may be some contribution from the interstitial nucleus of the ventral hippocampal commissure. The cells of this nucleus stain intensely (Fig. 1*b*), but are larger than those of the medial septal and diagonal band nuclei, and are unusual in containing some pseudocholinesterase (found intraneuronally elsewhere in the forebrain only in the anterior nuclei of the thalamus). Our observations suggest, therefore, that the cholinergic neurons of the cingulum, dorsal fornix and fimbria belong to the afferent hippocampal system described by several workers, for example, Daitz and Powell[4] and Cragg and Hamlyn[5,6].

We have tried to confirm experimentally the polarity of the stained fibres related to the hippocampus in rats which have been subjected to lesions involving the tracts and allowed to survive four days. In these animals fibres caudal to the lesion fail to stain, whereas those immediately rostral to it dilate, stain more intensely than the equivalent fibres on

the unoperated side, and become characteristically beaded[7]. We believe that this constant finding is due to enzyme accumulating on the cell body side of the axon adjacent to the cut and disappearing on the other side, as was found to occur in peripheral nerve by Sawyer[8], and indicates that the cholinergic fibres of the cingulum, dorsal fornix and fimbria are directed caudally. We hope to extend this method to investigate the polarity of other cholinergic tracts of the forebrain.

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Effect of Limb Ablation on Neurones in *Xenopus* Larvæ

In the spinal cord of larval Anura, the motor cells which innervate the muscles of the hind limbs form ventral horns distinct both in position and time of appearance from the series of primary motor cells whose axons run to the trunk muscles. In the tadpole of *Xenopus laevis*, there are about 4,000 ventral horn cells at the time of their differentiation from the mantle layer of the cord, a number which has fallen to 1,200 by metamorphosis some eight weeks later[1]. 'Histogenic cell degeneration'[2] accompanies the differentiation of these neurones, but on a scale much beyond that required merely to reduce their number to the adult-level. It seems that, for every ventral horn cell that persists, some eight or nine undergo cell death during development. Differentiation of the ventral horn is thus accompanied by a continuous turnover of the constituent neuroblasts.

If the larval hind limb is amputated at the thigh, a sequence of cellular changes is initiated within both the cord and the dorsal root ganglia. From the second to the third day after amputation, the number of cell degenerations within the ventral horn on the operated side is increased, and the total number of cells thereby temporarily diminished. While the degeneration which normally accompanies differentiation of the ventral horn can be temporarily abolished by X-rays, the additional cell deaths consequent on limb amputation are unaffected by radiation.

Fresh neuroblasts from the mantle layer, however, enter the ventral horn, and the deficit in cell number is made good. This movement of cells continues beyond the level required to restore the original total, and from the fifth to the fifteenth day after amputation the number of ventral horn cells on the operated side is greater than that on the other. Finally, a second phase of cell degeneration reduces the ventral horn to a third of its normal total of cells. This final destruction of neurones affects particularly the posterior two-thirds of the ventral horn, which is thus shown to be principally concerned with the innervation of distal limb segments. The leg only rarely regenerates when the operation is performed at late larval stages.

While these fluctuations in cell number are in progress, various changes are occurring in the ventral horn cells the axons of which have been severed by the operation. Attention was concentrated on changes in the Nissl substance and in the cholinesterase activity. Changes in Nissl substance were studied by ultra-violet absorption and controlled staining with basic dyes. Changes in the enzyme activity were studied by a special modification[3] of the thiocholine technique applied to small but intact specimens which were afterwards embedded in paraffin and sectioned. The sections were counterstained with buffered cresyl violet so that both Nissl substance and enzyme activity could be studied in the same neurone. In some of these preparations 10^{-4} *M* ethopropazine, a selective inhibitor of pseudocholinesterase, was used to confirm that only the distribution of true cholinesterase was being studied.

From the third to the fifth day, the ventral horn cells on the operated side show the typical reactions which were first described by Nissl in 1892 as 'chromatolysis', and have since been confirmed by numerous observers. The Nissl substance largely disappears, the cell cytoplasm becomes swollen, the nucleus moves towards the cell surface on one side, and the nuclear membrane becomes uneven in outline. By the eighth day, most neurones are recovering from this condition. The cytoplasm regains its normal dimensions, and, as the Nissl substance is re-formed, the chromosomal network within the nucleus becomes unusually distinct. In some of the largest cells this phase is succeeded by one in which cytoplasmic basiphilic material becomes densely piled round the nuclear membrane. This dense zone extends on opposite sides of the nucleus towards each pole of the cell. After the final phase of cell degeneration within the ventral horn, cells of this type are no longer to be found.

During the initial stages of chromatolysis the enzyme activity of the ventral horn cells on the operated side is at least as great as that on the control side and is often significantly greater (Figs. 2*A* and 2*B*). This enhanced enzyme activity is no longer present a week after ablation, and from then onwards an increasing proportion of cells on the operated side show only weak activity (Figs. 3*A* and 3*B*). Of such cells, although some are new immigrants which have not yet acquired the enzyme in any concentration, others are recovering from chromatolysis, and may show a dense perinuclear ring of basiphilic material. The weakly reacting neurones disappear from the ventral horn in the final wave of degeneration, after which the remaining cells, though of different sizes, are all strongly reacting (Fig. 5).

The most mature cells within the dorsal root ganglia of later larvæ show a weak but definite reaction for cholinesterase, the distribution of which can be studied by prolonging the incubation time in the thiocholine technique, and here, too, a sequence of changes is evident in those ganglia which supplied an ablated limb. Thus, after a week many of the cells no longer stain (Figs. 4*A* and 4*B*); during the third week many cells degenerate, leaving a ganglion which is much smaller than on the control, unoperated side but which contains about the same proportion of stained cells (Fig. 5).

Marked changes also occur peripherally. In the nerve trunk supplying a normal hind limb a proportion of the fibres stain for true cholinesterase. Following limb ablation this staining becomes much more intense, and individual fibres become noticeably distended (Fig. 1). Accumulation of enzyme in the

severed axons is detectable near the cut ends within a few hours, and during the next few days it gradually increases in extent backwards towards the spinal cord at a rate of about half a millimetre per day. Later, this staining becomes less intense and eventually the fibres degenerate. Similar changes have been observed in the rat forebrain following lesions which interrupt cholinesterase-positive tracts to the hippocampus[4].

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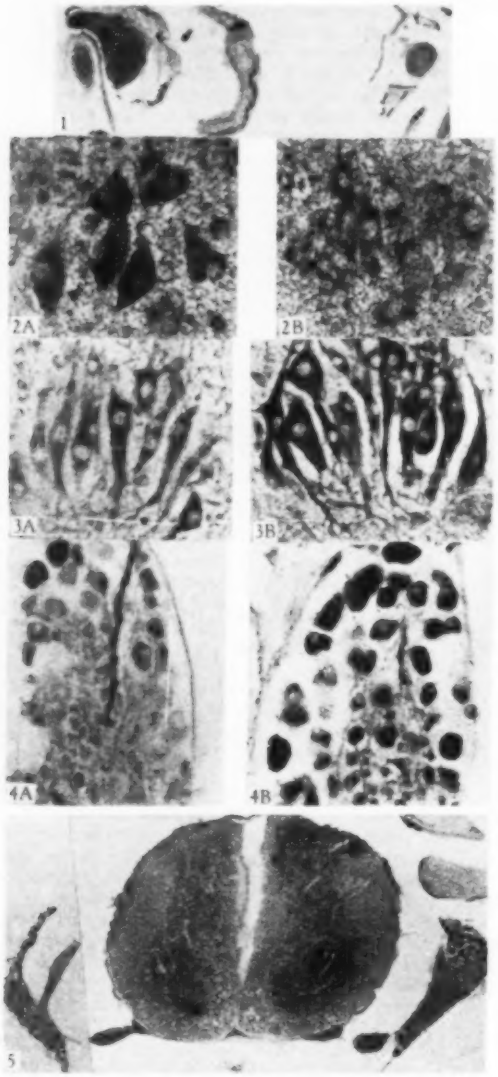
[3] Lewis, P. R., *Brit. Anat.*, **1** (1961).
[4] Shute, C. C. D., and Lewis, P. R., see preceding communication.



Figs. 1–5. All figures are from transverse sections prepared by the modified thiocholine technique through late larvæ of *Xenopus laevis* at various times after amputation of one hind limb. In each figure the operated side is shown on the left

Fig. 1. Through level of the sciatic nerves; 3 days after amputation. The nerve on the operated side is swollen and intensely stained

Fig. 2. Through level of the ventral horn; 4 days after amputation. The chromatolytic neurones, with displaced nuclei (*A*), are more intensely stained than the normal ones on the unoperated side (*B*)

Fig. 3. Through level of the ventral horn; 7 days after amputation. The post-chromatolytic neurones (*A*) are now less intensely stained than the normal ones (*B*)

Fig. 4. Through dorsal root ganglia supplying the hind limbs; 8 days after amputation. The proportion of strongly stained cells is much lower on the operated side (*A*) than on the normal side (*B*)

Fig. 5. Through dorsal root ganglia and cord; 18 days after amputation. There are now fewer cells in both the dorsal root ganglia and the ventral horn on the operated side

VIROLOGY

Determination of the Concentration of Myxoviruses and of Some Specific Antisera, based on Neuraminidase Activity

Of the different properties of the viruses of the myxogroup, for example, infectivity, antigenic properties, haemagglutination and enzymic activity, only haemagglutination has so far provided moderately rapid and accurate titration methods for the determination of myxovirus concentrations. A disadvantage of these methods is the necessary use of red blood cells, which are difficult to standardize.

We have devised a method for determination of myxovirus concentrations, based on the enzymic activity of the virus particles. The action of the virus enzyme—its ability to destroy the haemagglutination-inhibitory capacity of some mucoproteins or to elute the virus from red blood cells—always leads to the splitting off of a sialic acid, mostly N-acetylneuraminic acid[1]. This neuraminidase activity can be measured by determining the amount of free sialic acid released by the enzyme when the virus is incubated at 37° C. with a suitable substrate. As substrates we use the mucoprotein prepared by alcohol precipitation from human urine[2], or the compound of low molecular weight N-acetylneuraminyl-lactose isolated from cow

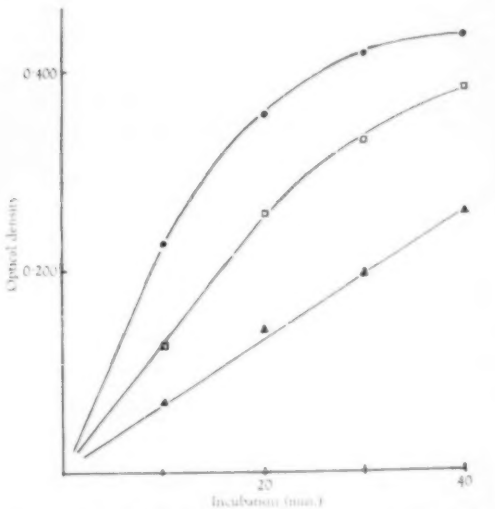


Fig. 1. Cleavage of N-acetylneuraminyl-lactose (100 μgm./ml.) by a sample of influenza virus neuraminidase (strain A_2-Singapore 1957) in several dilutions (▲, × 64; □, × 32; ●, × 16), as a function of the incubation time

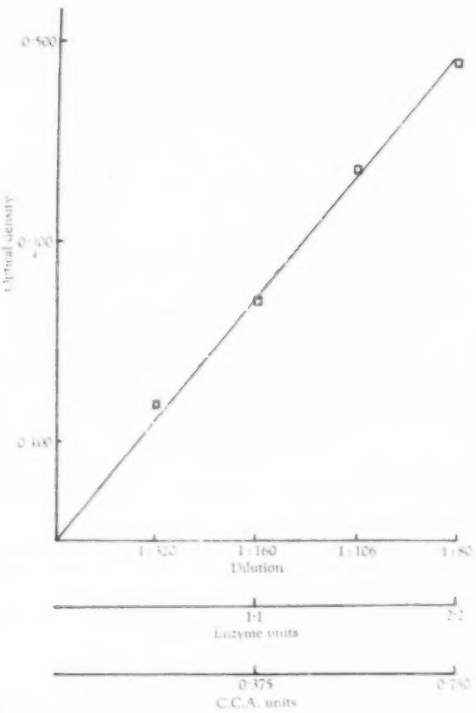


Fig. 2. Determination of neuraminidase (virus)-concentration, strain A_2-Singapore 1957 by cleavage of N-acetylneuraminyl-lactose. Relation between dilution factor and N-acetylneuraminic acid released (optical density) after incubation for 30 min. The virus dilutions on the horizontal axis are compared both with the amount of enzyme units in the sample (one unit representing the amount of enzyme that releases 1 μmole of N-acetylneuraminic acid in 1 min. under the pH and temperature conditions used) and with the amount of haemagglutinin (chicken red cell agglutination units (ref. 6))

colostrum by a procedure rather similar to that used for N-acetyl-O-acetylneuraminyl-lactose[3]. The free N-acetylneuramic acid is estimated by the $NaIO_4$-thiobarbituric assay of Warren[4], which assay is negative for the N-acetylneuraminic acid, ketosidically linked in the substrate. We use the Warren method with some modifications such as a correction for slight cloudiness by subtracting the optical density at 600 mμ or by mixing the organic phase with 2·5 per cent v/v acetone to avoid any cloudiness. Cuvettes with a 4-cm. light path were used.

In Fig. 1 the action of a myxovirus enzyme is shown. During the incubation of the substrate (here N-acetylneuraminyl-lactose) and the enzyme—influenza virus A_2 1(1957 Singapore)—at 37° C., samples are taken at various intervals for the determination of the N-acetylneuraminic acid release. By the addition to the samples of the strongly acid $NaIO_4$-H_3PO_4 reagent the enzyme reaction is stopped promptly. It may be seen that when the virus and substrate concentrations are rightly chosen, the amount of N-acetylneuraminic acid released is directly proportional to the incubation time. With this method it can further be shown that myxovirus neuraminidases follow Michaelis-Menten kinetics[5].

When a series of virus preparations of suitable dilution are incubated with the substrate for a standard time, the relationship between the N-acetylneuraminic acid released and the virus dilution factor is found to be linear (Fig. 2). It is thus possible to express the virus concentration in enzyme units; furthermore, the strength of an unknown virus suspension can be determined by measuring the enzymic activity of several dilutions of this suspension and comparing it with that of a standard. When the determination is performed with only one virus dilution, in the range where the effect varies linearly with the concentration, the accuracy is equal to that of the chicken red cell agglutination method[6].

We applied this method to the influenza virus strains: A PR_8(1934 U.S.A.), A_1FM_1(1947 U.S.A.), A_1 5(1953 Nederland), A_2 1(1957 Singapore), A_2 305(1957 Japan), B Lee(1940 U.S.A.), B Bon(1942 Australia), B 33(1958 Johannesburg), to A Swine influenza Swine 15(1930 U.S.A.) and to Newcastle disease, strain Hitchner $B1$. Determinations can only be carried out, however, with more or less purified virus suspensions, since crude allantoic fluid was found to contain inhibitory substances. The concentration of receptor-destroying enzyme in filtrates of *Vibrio cholerae* can be determined in the same way. It is interesting to note that the quotient neuraminidase units/chicken red-cell agglutination units varies strongly for the different virus types, being highest for the two $A2$ strains.

Myxovirus antibodies can be demonstrated by their inhibition of viral haemagglutination. It seemed interesting to know if the viral enzymic activity is also blocked by antiserum. This proved to be true for the antibodies against two Asian influenza strains A_2 1(1957 Singapore) and A_2 305(1957 Japan), but not for some other strains, for example, A_1 5(1953 Nederland) and B Bon(1942 Australia). The concentration of the antibodies against the two Asian strains can be determined by measuring the degree of inhibition of enzymic activity (Fig. 3). In these antibody determinations we use monovalent vaccines, prepared with β-propiolactone, which retain their enzymic activity.

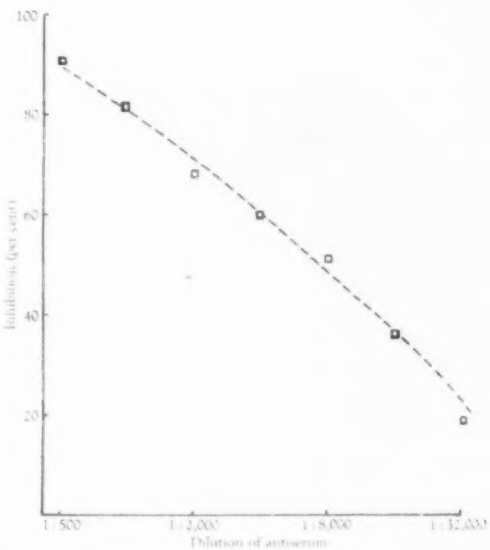


Fig. 3. Inhibition of neuraminidase activity of A_2-Singapore 1957 by homologous rabbit antiserum

This, and further work, will be reported in detail elsewhere. We acknowledge the technical assistance of Miss A. J. Schirmer.

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[1] Gottschalk, A., *Advances in Enzymol.*, **20**, 135 (1958). Zilliken, F., and Whitehouse, M. W., *Advances in Carbohydrate Chem.*, **13**, 237 (1958).
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[3] Kuhn, R., and Brossmer, R., *Chem. Ber.*, **89**, 2013 (1956).
[4] Warren, L., *J. Biol. Chem.*, **234**, 1971 (1959).
[5] Walop, J. N., Boschman, Th. A. C., and Jacobs, J., *Biochim. Biophys. Acta*, **44**, 185 (1960).
[6] Miller, G. L., and Stanley, W. M., *J. Exp. Med.*, **79**, 185 (1944).

MISCELLANY

Sampling of Sub-micron Particles for Electron Microscopy

In recent work on the attachment of radioactive particles to Aitken nuclei, we have been concerned with the sampling and subsequent examination by electron microscopy of Aitken nuclei in the size-range 0·01–0·1μ diameter. A thermal precipitator was used for sampling, and the nuclei were at first collected on an electron microscope grid covered by a carbon film, instead of on the usual glass coverslip. Doubts arose as to whether the sample was a uniform one or whether there was preferential deposition over the copper bars of the grid by reason of the increased thermal gradient in the neighbourhood of the bars or by sagging of the carbon film between them. This effect has already been reported by Cartwright[1], who, to obtain uniform samples, used the thermal precipitator with the usual coverslips coated with a 'Formvar' film. After collection of the sample the film was scratched into sections of suitable size, floated off the coverslip in distilled water and placed on a grid for subsequent examination by electron microscopy. Cartwright observed preferential deposition on the grid bars of dust particles up to a few microns in diameter by means of an optical microscope, but in the present work the Aitken nuclei were too small for optical microscopy, and nuclei deposited over the grid bars could not be seen with the electron microscope.

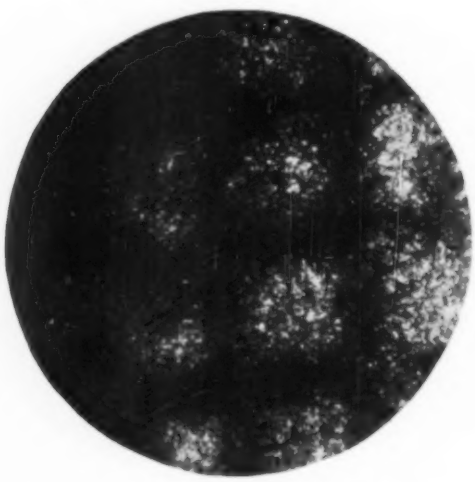

Fig. 1. Autoradiograph of thermal precipitator sample of Aitken nuclei, labelled with thorium *B*, collected on carbon-coated electron microscope grid. (× 175)

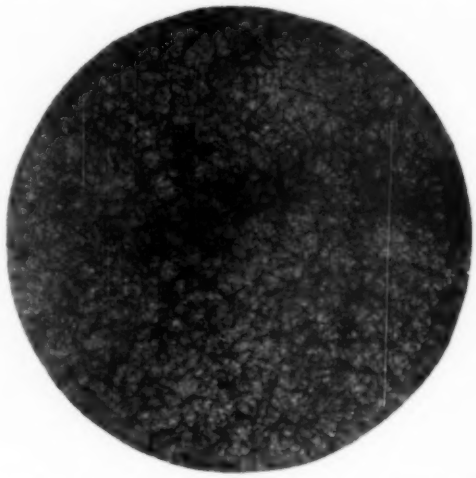

Fig. 2. Autoradiograph of simultaneous sample collected on carbon-coated coverslip. (× 175)

The technique finally used to test the uniformity of the sample was to mark the Aitken nuclei with atoms of thorium *B* and then to autoradiograph the samples. Areas where Aitken nuclei were concentrated could then be distinguished by the local concentration of alpha tracks. The autoradiographs shown are from the same thermal precipitator sample taken with an electron microscope grid (Fig. 1) and a coverslip (Fig. 2), both coated with an evaporated film of carbon, on opposite sides of the heated wire. It is apparent that the deposit on the coated coverslip is very much more uniform than that on the grid. Evaporated carbon films were used in preference to 'Formvar' because of ease of production and increased strength in the electron beam.

The method of marking the nuclei with thorium *B* was to pass filtered air at the rate of 200 cm.³/min. through a solution of 5 mc. of radiothorium (thorium-228) in 40 ml. of 0·05 normal nitric acid. The thoron carried over was then passed into the vessel containing the nuclei to be marked. The short-lived thoron decayed in the vessel to give the thorium *B* atoms which attached themselves to the nuclei present.

Because of its low sampling-rate, the thermal precipitator is not a very convenient instrument in the present application, and we hope to develop a method of sampling on to carbon-coated coverslips by electrostatic precipitation.

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[1] Cartwright, J., *Brit. J. App. Phys.*, Supp. No. 3 (1954).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 30

UNIVERSITY OF LONDON (in the Assembly Hall, Institute of Education, Malet Street, London, W.C.1), at 5.15 p.m.—Dr. P. F. R. Venables: "The Problems of Isolation in Technical Education".*

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. J. P. Den Hartog (Massachusetts Institute of Technology): "Topics in Mechanical Vibrations. I: Torsional Vibrations in Engine Systems caused by Gear Inaccuracies".* (Further lectures on February 1 and 2.)

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Dr. James Taylor: "The Springs of Progress". (Second of three Cantor Lectures on "The Modern Chemical Industry in Great Britain".)

Tuesday, January 31

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. W. A. Smeaton: "Science and Politics during the French Revolution".*

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. H. E. M. Kay: "Transplantation of Haemopoietic Cells".* (Sixth of fifteen lectures on "The Scientific Basis of Medicine" organized by the British Postgraduate Medical Federation.)

SOCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. L. S. Yoxall: "Instrumentation—Past, Present and Future".

Wednesday, February 1

UNIVERSITY OF LONDON (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Dr. F. G. J. Hayhoe: "Cytology of Leukæmic Cells".*

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5 p.m.—Dr. D. J. Bartholomew: "A Test of Homogeneity of Means under Restrictive Alternatives".

ROYAL SOCIETY OF MEDICINE, HISTORY OF MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 5.15 p.m.—Mr. J. T. Rowling: "Pathological Changes in Mummies"; Dr. P. A. Zorab: "The Historical and Prehistorical Background to Ankylosing Spondylitis"; Mrs. Glemser: "The Anthropological Applications of Blood Grouping".

BRITISH INSTITUTION OF RADIO ENGINEERS, RADAR GROUP (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. D. E. N. Davies: "A Fast Electronically Scanned Receiving System".

INSTITUTE OF INFORMATION SCIENTISTS (at the Swedenborg Society Hall, 20 Bloomsbury Way, London, W.C.1), at 6.15 p.m.—Mr. F. W. Cousins: "Language at the Interface of Technology and the Law".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. J. C. Pinder: "The Economics of Agricultural Chemicals and Fertilizers".

SOCIETY FOR ANALYTICAL CHEMISTRY, PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Meeting on "X-Ray Fluorescence". Mr. K. M. Bills: "X-Ray Fluorescence Spectroscopy"; Dr. F. Brown: "Some Analytical Applications of X-Ray Fluorescence Spectrometry".

Thursday, February 2

INSTITUTE OF PHYSICS AND THE PHYSICAL SOCIETY (in the Physics Department of Imperial College, Prince Consort Road, South Kensington, London, S.W.7), at 2.45 p.m.—Dr. J. H. Sanders: "The Optical Maser"; Dr. W. R. Hindmarsh: "Collision Broadening and Shift in Atomic Spectra".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. W. D. M. Paton, F.R.S.: "A Theory of Drug Action Based on the Rate of Drug-receptor Combination"; Mr. B. B. Fovcott, Mr. E. G. Gray and Mr. R. W. Guillery: "Synaptic Structure and its Alteration with Environmental Temperature: a Light and Electron Microscope Study of the Central Nervous System of Lizards".

INSTITUTE OF REFRIGERATION (at the Institute of Marine Engineers, The Memorial Building, 76 Mark Lane, London, E.C.3), at 5.30 p.m.—Mr. Carl Munters and Mr. Lennart Lindqvist: "A New Conception in Cooling Tower Design".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. A. J. Blundell, Mr. A. E. Garside, Mr. R. G. Hibberd and Mr. I. Williams: "Silicon Power Rectifiers".

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. C. E. Ford: "The Inter-relationship of Nucleus and Cytoplasm".* (Seventh of fifteen lectures on "The Scientific Basis of Medicine" organized by the British Postgraduate Medical Federation.)

UNIVERSITY OF LONDON (in the New Physics Building, Imperial College of Science and Technology, London, S.W.7), at 5.30 p.m.—Prof. A. B. Pippard, F.R.S.: "The Electronic Structure of Metals".* (First of three lectures. Further lectures on February 9 and 16.)

INSTITUTE OF METALS, LONDON LOCAL SECTION (at 17 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. P. G. Forrester: "The Development of Some New Bearing Materials".

UNIVERSITY OF LONDON (at Wye College, Wye, near Ashford, Kent), at 8.15 p.m.—Prof. R. Brown: "Morphogenesis in Plants".*

Friday, February 3

INSTITUTION OF ELECTRICAL ENGINEERS, MEDICAL ELECTRONICS DISCUSSION GROUP (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "Recent Technical Developments in Eye Movement Recording" opened by Dr. P. A. Merton and Dr. C. Rashbass.

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (joint meeting with the MANCHESTER SECTION, in the Robinson Theatre, The University, Manchester), at 6 p.m.—Mr. D. H. Matthews: "Surface Active Agents in Bituminous Road Materials".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (joint meeting with the BRIGHTON TECHNICAL COLLEGE CHEMICAL SOCIETY, at Brighton Technical College, Brighton), at 7.30 p.m.—Sir H. W. Melville, F.R.S.: "Research and Development in D.S.I.R. Stations".

Saturday, February 4

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. F. S. Wallis: "Prehistoric Stone Factories".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

BIOCHEMIST (Principal grade), to take charge of the Biochemical Department of the Group Laboratory, Lakin Road, Warwick—The Group Secretary, South Warwickshire Hospital Group, 50 Holly Walk, Leamington Spa (February 2).

ASSISTANT LECTURER OR LECTURER IN THE DEPARTMENT OF PURE MATHEMATICS—The Registrar, The University, Liverpool (February 3).

LECTURER OR ASSISTANT LECTURER IN INORGANIC CHEMISTRY—The Clerk to the Governors, Chelsea College of Science and Technology, Manresa Road, London, S.W.3 (February 3).

LECTURER IN AGRICULTURE (ANIMAL PRODUCTION); and a DEPARTMENTAL ASSISTANT IN ANIMAL PHYSIOLOGY, at the School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham (February 4).

LECTURER (with graduate qualifications and wide experience of the paper-making industry) IN PAPER TECHNOLOGY—The Principal, Medway College of Technology, Horsted, Maidstone Road, Chatham, Kent (February 4).

RESEARCH ASSISTANT (with a degree in mathematics or equivalent qualifications, and preferably previous experience of electronic computers) IN THE COMPUTING MACHINE LABORATORY, to assist in the operation of a computing service on the Mercury and Atlas electronic computers—The Registrar, The University, Manchester 13 (February 4).

SENIOR OR JUNIOR RESEARCH ASSISTANT, for the M.R.C. Research Group in Enzymology in the Department of Chemical Pathology—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (February 4).

LECTURER (male) IN EDUCATION—The Principal, Borough Road College, Isleworth, Middlesex (February 6).

ASSISTANT LECTURER IN PHILOSOPHY—The Registrar, The University, Leicester (February 10).

LECTURER IN PHYSICS; and a LECTURER IN PHYSIOLOGICAL PSYCHOLOGY—The Registrar, The University, Leicester (February 10).

LECTURER IN PURE MATHEMATICS; a LECTURER IN APPLIED MATHEMATICS; an ASSISTANT LECTURER IN PURE MATHEMATICS; and an ASSISTANT LECTURER IN APPLIED MATHEMATICS—The Registrar, The University, Leicester (February 10).

LECTURER (with special interest in genetics) IN BOTANY—The Registrar, The University, Leicester (February 10).

LECTURER OR ASSISTANT LECTURER IN STATISTICS IN THE DEPARTMENT OF PURE MATHEMATICS—The Registrar, The University, Edgbaston, Birmingham 15 (February 15).

READER IN APPLIED MATHEMATICS—The Clerk to the Governors, Chelsea College of Science and Technology, Manresa Road, London, S.W.3 (February 15).

ASSISTANT LECTURER (with a good honours degree in either botany or agricultural botany, and a special interest in mycology or plant pathology) IN THE DEPARTMENT OF AGRICULTURAL BOTANY—The Registrar, University College of Wales, Aberystwyth (February 18).

READER IN PHARMACOLOGY; a LECTURER IN SOCIOLOGY; a LECTURER IN ORGANIC CHEMISTRY; a LECTURER IN FOOD SCIENCE; a LECTURER IN AGRICULTURE (ANIMAL PRODUCTION); LECTURERS and ASSISTANT LECTURERS IN CIVIL ENGINEERING and ELECTRICAL ENGINEERING; and ASSISTANT LECTURERS IN APPLIED MATHEMATICS and BOTANY—The Registrar, The University, Nottingham (February 18).

LECTURER IN AERONAUTICAL ENGINEERING—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (February 20).

READER IN APPLIED MATHEMATICS at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 24).

FELLOW AND LECTURER (mathematician with interests in the field of theoretical physics) IN MATHEMATICS—The Rector, Exeter College, Oxford (February 25).

LECTURER OR ASSISTANT LECTURER IN APPLIED MATHEMATICS—The Secretary and Registrar, University College of North Wales, Bangor, North Wales (February 27).

ASSISTANT LECTURER OR LECTURER (with qualifications in any branch of pure mathematics and special interests in numerical analysis or mathematical statistics) IN THE DEPARTMENT OF MATHEMATICS; and an ASSISTANT LECTURER (with special qualifications in inorganic chemistry or in physical chemistry) IN THE DEPARTMENT OF CHEMISTRY—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (February 28).

This, and further work, will be reported in detail elsewhere. We acknowledge the technical assistance of Miss A. J. Schirmer.

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MISCELLANY

Sampling of Sub-micron Particles for Electron Microscopy

In recent work on the attachment of radioactive particles to Aitken nuclei, we have been concerned with the sampling and subsequent examination by electron microscopy of Aitken nuclei in the size-range 0·01–0·1μ diameter. A thermal precipitator was used for sampling, and the nuclei were at first collected on an electron microscope grid covered by a carbon film, instead of on the usual glass coverslip. Doubts arose as to whether the sample was a uniform one or whether there was preferential deposition over the copper bars of the grid by reason of the increased thermal gradient in the neighbourhood of the bars or by sagging of the carbon film between them. This effect has already been reported by Cartwright[1], who, to obtain uniform samples, used the thermal precipitator with the usual coverslips coated with a 'Formvar' film. After collection of the sample the film was scratched into sections of suitable size, floated off the coverslip in distilled water and placed on a grid for subsequent examination by electron microscopy. Cartwright observed preferential deposition on the grid bars of dust particles up to a few microns in diameter by means of an optical microscope, but in the present work the Aitken nuclei were too small for optical microscopy, and nuclei deposited over the grid bars could not be seen with the electron microscope.

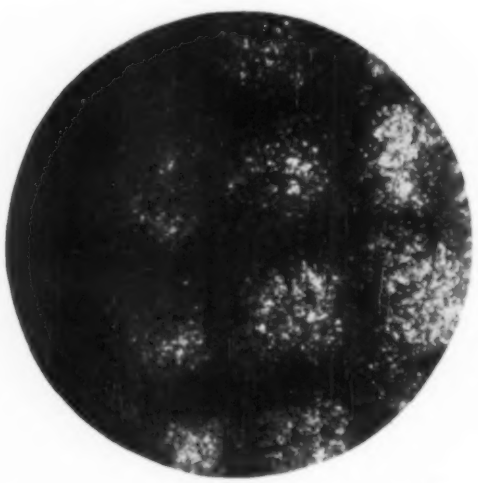

Fig. 1. Autoradiograph of thermal precipitator sample of Aitken nuclei, labelled with thorium *B*, collected on carbon-coated electron microscope grid. (× 175)

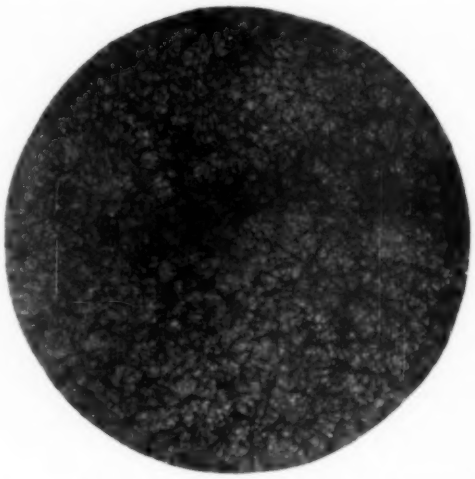

Fig. 2. Autoradiograph of simultaneous sample collected on carbon-coated coverslip. (× 175)

The technique finally used to test the uniformity of the sample was to mark the Aitken nuclei with atoms of thorium *B* and then to autoradiograph the samples. Areas where Aitken nuclei were concentrated could then be distinguished by the local concentration of alpha tracks. The autoradiographs shown are from the same thermal precipitator sample taken with an electron microscope grid (Fig. 1) and a coverslip (Fig. 2), both coated with an evaporated film of carbon, on opposite sides of the heated wire. It is apparent that the deposit on the coated coverslip is very much more uniform than that on the grid. Evaporated carbon films were used in preference to 'Formvar' because of ease of production and increased strength in the electron beam.

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Because of its low sampling-rate, the thermal precipitator is not a very convenient instrument in the present application, and we hope to develop a method of sampling on to carbon-coated coverslips by electrostatic precipitation.

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(Meetings marked with an asterisk • are open to the public)

Monday, January 30

UNIVERSITY OF LONDON (in the Assembly Hall, Institute of Education, Malet Street, London, W.C.1), at 5.15 p.m.—Dr. P. F. R. Venables: "The Problems of Isolation in Technical Education".•

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. J. P. Den Hartog (Massachusetts Institute of Technology): "Topics in Mechanical Vibrations. 1: Torsional Vibrations in Engine Systems caused by Gear Inaccuracies".• (Further lectures on February 1 and 2.)

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Dr. James Taylor: "The Springs of Progress". (Second of three Cantor Lectures on "The Modern Chemical Industry in Great Britain".)

Tuesday, January 31

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. W. A. Smeaton: "Science and Politics during the French Revolution".•

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. H. E. M. Kay: "Transplantation of Hæmopoietic Cells".• (Sixth of fifteen lectures on "The Scientific Basis of Medicine" organized by the British Postgraduate Medical Federation.)

SOCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. L. S. Yoxall: "Instrumentation—Past, Present and Future".

Wednesday, February 1

UNIVERSITY OF LONDON (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Dr. F. G. J. Hayhoe: "Cytology of Leukæmic Cells".•

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5 p.m.—Dr. D. J. Bartholomew: "A Test of Homogeneity of Means under Restrictive Alternatives".

ROYAL SOCIETY OF MEDICINE, HISTORY OF MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 5.15 p.m.—Mr. J. T. Rowling: "Pathological Changes in Mummies"; Dr. P. A. Zorab: "The Historical and Prehistorical Background to Ankylosing Spondylitis"; Mrs. Glemser: "The Anthropological Applications of Blood Grouping".

BRITISH INSTITUTION OF RADIO ENGINEERS, RADAR GROUP (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. D. E. N. Davies: "A Fast Electronically Scanned Receiving System".

INSTITUTE OF INFORMATION SCIENTISTS (at the Swedenborg Society Hall, 20 Bloomsbury Way, London, W.C.1), at 6.15 p.m.—Mr. F. W. Cousins: "Language at the Interface of Technology and the Law".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. J. C. Pinder: "The Economics of Agricultural Chemicals and Fertilizers".

SOCIETY FOR ANALYTICAL CHEMISTRY, PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Meeting on "X-Ray Fluorescence". Mr. K. M. Bills: "X-Ray Fluorescence Spectroscopy"; Dr. F. Frown: "Some Analytical Applications of X-Ray Fluorescence Spectrometry".

Thursday, February 2

INSTITUTE OF PHYSICS AND THE PHYSICAL SOCIETY (in the Physics Department of Imperial College, Prince Consort Road, South Kensington, London, S.W.7), at 2.45 p.m.—Dr. J. H. Sanders: "The Optical Maser"; Dr. W. R. Hindmarsh: "Collision Broadening and Shift in Atomic Spectra".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. W. D. M. Paton, F.R.S.: "A Theory of Drug Action Based on the Rate of Drug-receptor Combination"; Mr. B. B. Boycott, Mr. E. G. Gray and Mr. R. W. Guillery: "Synaptic Structure and its Alteration with Environmental Temperature: a Light and Electron Microscope Study of the Central Nervous System of Lizards".

INSTITUTE OF REFRIGERATION (at the Institute of Marine Engineers, The Memorial Building, 76 Mark Lane, London, E.C.3), at 5.30 p.m.—Mr. Carl Munters and Mr. Lennart Lindqvist: "A New Conception in Cooling Tower Design".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. A. J. Blundell, Mr. A. E. Garside, Mr. R. G. Hibberd and Mr. I. Williams: "Silicon Power Rectifiers".

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. C. E. Ford: "The Inter-relationship of Nucleus and Cytoplasm".• (Seventh of fifteen lectures on "The Scientific Basis of Medicine" organized by the British Postgraduate Medical Federation.)

UNIVERSITY OF LONDON (in the New Physics Building, Imperial College of Science and Technology, London, S.W.7), at 5.30 p.m.—Prof. A. B. Pippard, F.R.S.: "The Electronic Structure of Metals".• (First of three lectures. Further lectures on February 9 and 16.)

INSTITUTE OF METALS, LONDON LOCAL SECTION (at 17 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. P. G. Forrester: "The Development of Some New Bearing Materials".

UNIVERSITY OF LONDON (at Wye College, Wye, near Ashford, Kent), at 8.15 p.m.—Prof. R. Brown: "Morphogenesis in Plants".•

Friday, February 3

INSTITUTION OF ELECTRICAL ENGINEERS, MEDICAL ELECTRONICS DISCUSSION GROUP (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "Recent Technical Developments in Eye Movement Recording" opened by Dr. P. A. Merton and Dr. C. Rashbass.

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (joint meeting with the MANCHESTER SECTION, in the Robinson Theatre, The University, Manchester), at 6 p.m.—Mr. D. H. Matthews: "Surface Active Agents in Bituminous Road Materials".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (joint meeting with the BRIGHTON TECHNICAL COLLEGE CHEMICAL SOCIETY, at Brighton Technical College, Brighton), at 7.30 p.m.—Sir H. W. Melville, F.R.S.: "Research and Development in D.S.I.R. Stations".

Saturday, February 4

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. F. S. Wallis: "Prehistoric Stone Factories".•

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

BIOCHEMIST (Principal grade), to take charge of the Biochemical Department of the Group Laboratory, Lakin Road, Warwick—The Group Secretary, South Warwickshire Hospital Group, 50 Holly Walk, Leamington Spa (February 2).

ASSISTANT LECTURER or LECTURER IN THE DEPARTMENT OF PURE MATHEMATICS—The Registrar, The University, Liverpool (February 3).

LECTURER or ASSISTANT LECTURER IN INORGANIC CHEMISTRY—The Clerk to the Governors, Chelsea College of Science and Technology, Manresa Road, London, S.W.3 (February 3).

LECTURER IN AGRICULTURE (ANIMAL PRODUCTION); and a DEPARTMENTAL ASSISTANT IN ANIMAL PHYSIOLOGY, at the School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham (February 4).

LECTURER (with graduate qualifications and wide experience of the paper-making industry) IN PAPER TECHNOLOGY—The Principal, Medway College of Technology, Horsted, Maidstone Road, Chatham, Kent (February 4).

RESEARCH ASSISTANT (with a degree in mathematics or equivalent qualifications, and preferably previous experience of electronic computers) IN THE COMPUTING MACHINE LABORATORY, to assist in the operation of a computing service on the Mercury and Atlas electronic computers—The Registrar, The University, Manchester 13 (February 4).

SENIOR or JUNIOR RESEARCH ASSISTANT, for the M.R.C. Research Group in Enzymology in the Department of Chemical Pathology—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (February 4).

LECTURER (male) IN EDUCATION—The Principal, Borough Road College, Isleworth, Middlesex (February 6).

ASSISTANT LECTURER IN PHILOSOPHY—The Registrar, The University, Leicester (February 10).

LECTURER IN PHYSICS; and a LECTURER IN PHYSIOLOGICAL PSYCHOLOGY—The Registrar, The University, Leicester (February 10).

LECTURER IN PURE MATHEMATICS; a LECTURER IN APPLIED MATHEMATICS; an ASSISTANT LECTURER IN PURE MATHEMATICS; and an ASSISTANT LECTURER IN APPLIED MATHEMATICS—The Registrar, The University, Leicester (February 10).

LECTURER (with special interest in genetics) IN BOTANY—The Registrar, The University, Leicester (February 10).

LECTURER or ASSISTANT LECTURER IN STATISTICS IN THE DEPARTMENT OF PURE MATHEMATICS—The Registrar, The University, Edgbaston, Birmingham 15 (February 15).

READER IN APPLIED MATHEMATICS—The Clerk to the Governors, Chelsea College of Science and Technology, Manresa Road, London, S.W.3 (February 15).

ASSISTANT LECTURER (with a good honours degree in either botany or agricultural botany, and a special interest in mycology or plant pathology) IN THE DEPARTMENT OF AGRICULTURAL BOTANY—The Registrar, University College of Wales, Aberystwyth (February 18).

READER IN PHARMACOLOGY; a LECTURER IN SOCIOLOGY; a LECTURER IN ORGANIC CHEMISTRY; a LECTURER IN FOOD SCIENCE; a LECTURER IN AGRICULTURE (ANIMAL PRODUCTION); LECTURERS and ASSISTANT LECTURERS IN CIVIL ENGINEERING and ELECTRICAL ENGINEERING; and ASSISTANT LECTURERS IN APPLIED MATHEMATICS and BOTANY—The Registrar, The University, Nottingham (February 18).

LECTURER IN AERONAUTICAL ENGINEERING—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (February 20).

READER IN APPLIED MATHEMATICS at Queen Mary College—The Academic Registrar, University of London, Senate House, London W.C.1 (February 24).

FELLOW AND LECTURER (mathematician with interests in the field of theoretical physics) IN MATHEMATICS—The Rector, Exeter College, Oxford (February 25).

LECTURER or ASSISTANT LECTURER IN APPLIED MATHEMATICS—The Secretary and Registrar, University College of North Wales, Bangor, North Wales (February 27).

ASSISTANT LECTURER or LECTURER (with qualifications in any branch of pure mathematics and special interests in numerical analysis or mathematical statistics) IN THE DEPARTMENT OF MATHEMATICS; and an ASSISTANT LECTURER (with special qualifications in inorganic chemistry or in physical chemistry) IN THE DEPARTMENT OF CHEMISTRY—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (February 28).

CHAIR OF MATHEMATICS in the Royal College, Nairobi—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (February 28).

LECTURERS or ASSISTANT LECTURERS (3) IN PHYSICS—The Registrar, The University, Hull (February 28).

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWS IN CHEMISTRY, PHYSICS, BIOCHEMISTRY or GEOLOGY—The Registrar, The University, Leicester (March 4).

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOW IN CHEMISTRY AND PHYSICS—The Secretary, The University, Exeter (March 5).

ASSISTANT LECTURER IN CHEMISTRY; an ASSISTANT LECTURER IN GEOGRAPHY; and an ASSISTANT LECTURER IN PURE OR APPLIED MATHEMATICS at the University of Singapore, Malaya—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (March 31).

IMPERIAL CHEMICAL INDUSTRIES FELLOWS FOR RESEARCH IN PHYSICS, CHEMISTRY, COLLOID SCIENCE, BIOCHEMISTRY, ENGINEERING, METALLURGY, PHARMACOLOGY, CHEMOTHERAPY, or related subjects—The Secretary General of the Faculties, The University, The Old Schools, Cambridge (April 29).

DEAN OF THE FACULTY OF HOME SCIENCE, University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand and London, April 30).

GEOLOGISTS (4), to teach in the fields of mineralogy, petrology, petrography, palæontology, stratigraphy, structural geology, economic geology and geophysics—Escola de Geologia, Universidade da Bahia, Salvador, Bahia, Brazil.

MASTER TO TEACH SCIENCE, CHIEFLY PHYSICS AND CHEMISTRY—The Headmaster, King's College, Taunton, Somerset.

RESEARCH ASSISTANT (with an honours degree and preferably some design experience), to investigate high strain fatigue of metals (work suitable for higher degree)—Prof. H. Ford, Imperial College of Science and Technology, London, S.W.7.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

National Association for Mental Health. Annual Report, 1959–60. Pp. 55. (London: National Association for Mental Health, 1960.) [2710

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 701, Vol. 243 (27 October 1960): Coastal Interglacial Deposits of the English Channel. By R. G. West and B. W. Sparks. Pp. 95–133 + plate 16. (London: The Royal Society, 1960.) 14*s*. [2710

British Broadcasting Corporation. B.B.C. Engineering Monograph No. 32: A New Survey of the B.B.C. Experimental Colour Transmissions. By I. R. Atkins, A. R. Stanley and S. N. Watson. Pp. 31. (London: British Broadcasting Corporation, 1960.) 5*s*. [2710

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 1024, Vol. 253 (27 October 1960): The Boltzmann Equation for a Bounded Medium. 1: General Theory. By S. Simons. Pp. 137–184. (London: Royal Society, 1960.) 15*s*. [3110

Ciba (A.R.L.), Limited. Technical Notes, No. 214 (October 1960): Radio-frequency Heating, Part 2 (conclusion). Pp. 8. (Duxford: Ciba (A.R.L.), Ltd., 1960.) [3110

Hopkin and Williams, Ltd. Organic Chemical Reagents Monograph No. 41: 4: 7-Diphenyl-1: 10-Phenanthroline ("Bathophenanthroline"): Reagent for Iron. By E. J. Newman and G. Peters. Pp. 7. (Chadwell Heath: Hopkin and Williams, Ltd., 1960.) [3110

The International Association for the Exchange of Students for Technical Experience. Thirteenth Annual Report, 1960. Pp. 70. Report of I.A.E.S.T.E. in Great Britain for year ending September 1960. Pp. 12. (London: International Association for the Exchange of Students for Technical Experience, 1960.) [3110

Geomorphological Abstracts, No. 1 (June 1960). Pp. 23. Published four times a year in March, June, September and December. (London: K. M. Clayton, Department of Geography, London School of Economics and Political Science, 1960.) [3110

English Electric Valve Co., Ltd. E702 Storage Tubes. Pp. 28. (Chelmsford: English Electric Valve Co. Ltd., 1960.) [3110

The Registrar General's Statistical Review of England and Wales for the year 1958. Part 3: Commentary. Pp. xiv + 222. (London: H.M. Stationery Office, 1960.) 13*s*. net. [3110

Forestry Commission. Report on Forest Research for the year ended March, 1959. Pp. ix + 186 + 5 plates. 9*s*. 6*d*. net. Leaflet No. 2: *Ideligs cooleyi*; an Insect Pest of Douglas Fir and Sitka Spruce. By Dr. Myles Crooke. Pp. 8. 9*d*. net. (London: H.M. Stationery Office, 1960.) [3110

Ministry of Agriculture, Fisheries and Food. Bulletin No. 115: Construction and Heating of Commercial Glasshouses. Pp. iv + 98 + 8 plates. (London: H.M. Stationery Office, 1960.) 6*s*. net. [3110

Scottish Marine Biological Association. Annual Report, 1959–60. Pp. 28. (Millport, Isle of Cumbrae: Scottish Marine Biological Association, 1960.) 4*s*. [3110

Department of Scientific and Industrial Research: Building Research Station. National Building Studies Research Paper No. 31: Studies on Bridge-Deck Systems. Part 2: Bending Moments in a Plate-and-Girder System. By C. C. Ritchie. Pp. iv + 67. (London: H.M. Stationery Office, 1960.) 4*s*. net. [711

Institution of Gas Engineers. Publication No. 578: The Choice of Subjects for Research and Development. By Sir Harold Hartley. Pp. 9. (London: Institution of Gas Engineers, 1960.) [711

British Universities Film Council. Catalogue of Films for Universities. Pp. 166 + xxiv. (Glasgow: British Universities Film Council, Royal College of Science and Technology, 1960.) [711

Building Research Station Digest. Second Series, No. 4: Repairing Brickwork. Pp. 4. (London: H.M. Stationery Office, 1960.) 4*d*. [711

Planning, Vol. 26, No. 446 (7 November, 1960): More Planning in Pakistan. Pp. 309–336. (London: Political and Economic Planning, 1960.) 3*s*. 6*d*. [711

Other Countries

Fisheries Research Board of Canada. Biological Station, St. Andrews, N.B. General Series Circular No. 33 (September, 1960): Outlook for the Georges Bank Scallop Fishery. Pp. 2. (St. Andrews, N.B.: Fisheries Research Board of Canada, 1960.) [2410

Towards the Dissolution of the Thermodynamic Paradoxes. By Sven Svantesson. (Supplement to "Foundations of Thermodynamics, with Antitheses and Disputation."") Pp. 4. (Stockholm: Almqvist and Wiksell/Gebers, 1960.) [2410

Food and Agriculture Organization of the United Nations, Rome. Animal Health Branch Monograph No. 1: Diseases of Free-Living Wild Animals. By Dr. A. McDiarmid. Pp. iii + 91. (Rome: Food and Agriculture Organization of the United Nations, 1960.) [2610

Indian Forest Bulletin No. 171 (3), (New Series): A List of Insect Pests of Forest Plants in India and the Adjacent Countries. Part 4: List of Insect Pests of Plant Genera 'C' (concluded) (*Clausena* to *Cytisus*). By R. N. Mathur and Balwant Singh. Pp. 45. Rs. 5.24nP.: 8*s*. 3*d*. Indian Forest Bulletin No. 171 (4), (New Series): A List of Insect Pests of Forest Plants in India and Adjacent Countries. Part 5: List of Insect Pests of Plant Genera 'D to F' (*Dactyloclenium* to *Funtumia*). By R. N. Mathur and Balwant Singh. Pp. 165. Rs. 10.; 16*s*. Indian Forest Leaflet No. 161 (Entomology), *Chrysocraspeda olearia* Guénee, a Defoliator of *Eugenia Jambolana* (Geometridae: Lepidoptera). By R. N. Mathur. Pp. 4 + 1 plate. Rs. 0.87nP.; 1*s*. 3*d*. Indian Forest Records (New Series). Silviculture. Vol. 10, No. 8: General Standard Volume Tables for *Casuarina equisetifolia* Forest. By S. K. Seth and S. N. Dabral. Pp. 227–237. Rs. 2.75nP.; 1*s*. 6*d*. (Delhi: Manager of Publications, 1959 and 1960.) [2710

Earthquake Research Institute, University of Tokyo. Pp. 138. (Tokyo: The University, 1960.) [3110

British Honduras. Annual Report of the Forest Department for the year 1959. Pp. 20. (Belize: Forest Department, 1960.) [3110

Canada: Department of Mines and Technical Surveys. Geological Survey of Canada. Bulletin No. 59: The Jurassic Faunas of the Canadian Arctic: Lower Jurassic and Lowermost Middle Jurassic Ammonites. By Hans Frebold. Pp. vi + 33 + 15 plates. 1.25 dollars. Memoir No. 307: Atlin Map-Area, British Columbia (104N). By J. D. Aitken. Pp. ix + 89 (4 plates). 1 dollar. Memoir No. 314: Mississippian Horton Group of Type Windsor-Horton District, Nova Scotia. By W. A. Bell. Pp. ix + 112 (24 plates). 2 dollars. (Ottawa: Queen's Printer, 1960.) [3110

International Symposium on the Chemistry of Natural Products, 1960. (Melbourne 15–18 August; Canberra 19–20 August; Sydney, 21–25 August.) Organized by the Australian Academy of Sciences, under the auspices of The Section of Organic Chemistry, International Union of Pure and Applied Chemistry. Symposium Handbook. Pp. 96 + 4 plates. Abstracts of Papers. Pp. 100. (Canberra: Australian Academy of Sciences, 1960.) [3110

Transvaal Museum, Pretoria. Report for the year ending 31st March, 1960. Pp. 46. (Pretoria: Transvaal Museum, 1960.) [3110

Mitteilungen des Deutschen Wetterdienstes. Nr. 22 (Band 3): Über den Einfluss von Exposition und Bewichs auf die Erdbodentemperaturen. Von Karl Heigel. Pp. 36. (Offenbach a M.: Selbstverlag des Deutschen Wetterdienstes, 1960.) [3110

National Museum, Bloemfontein. Annual Report for the year ended 31st March, 1960. Pp. 22. Memoir No. 1: Prehistory of the Matjes River Rock Shelter. By Dr. J. P. Louw. Pp. 143 (7 Plates). (Bloemfontein: National Museum, 1960.) [3110

International Atomic Energy Agency, Vienna. Some Recent Activities of I.A.E.A. (A Service to the Specialized Press.) Pp. 41. (Vienna: International Atomic Energy Agency, 1960.) [3110

2000 A.D.: a Biologist's Thoughts on the Next Forty Years. By Sir F. Macfarlane Burnet. (Sir John Morris Memorial Lecture, 1959.) Pp. 15. (Melbourne: Melbourne University Press; London: Cambridge University Press, 1960.) 2*s*. 6*d*. net. [3110

Universidade de Sao Paulo. Contribuicoes Avulsas fo Instituto Oceanografico. No. 1: Radiacao Solar e Insolacao em Cananeia. Por A. Garcia Occhipinti. Pp. 40. No. 2: Propagacao do Onda de Mare em Torno da Ilha de Cananeia. Por I. C. Miniussi. Pp. 8. (Sao Paulo: Universidade de Sao Paulo, 1959.) [711

Metropolitan Life Insurance Company, Statistical Bulletin, Vol. 41 (September 1960): Trends in Survival at the Older Ages. Joint Effect of Blood Pressure Level and Impairments. Incidence of Poliomyelitis Decreases. Fatal Accidents in Later Life. Pp. 12. (New York Metropolitan Life Insurance Company, 1960.) [711

Inter-American Tropical Tuna Commission. Annual Report for the year 1959. Pp. 1 + 156. (La Jolla, California: Inter-American Tropical Tuna Commission, 1960.) [711

United States Department of Agriculture. Farmers' Bulletin No. 2149: Soil and Water Management in Irrigated Sugar Beet Fields. By J. L. Haddock. Pp. 12. (Washington, D.C.: Government Printing Office, 1960.) 10 cents. [711

United States Department of Commerce: Coast and Geodetic Survey. Technical Bulletin No. 12: Use of Artificial Satellites for Navigation and Oceanographic Surveys. By Paul D. Thomas. Pp. 1 + 24. (Washington, D.C.: Government Printing Office, 1960.) 25 cents. [711

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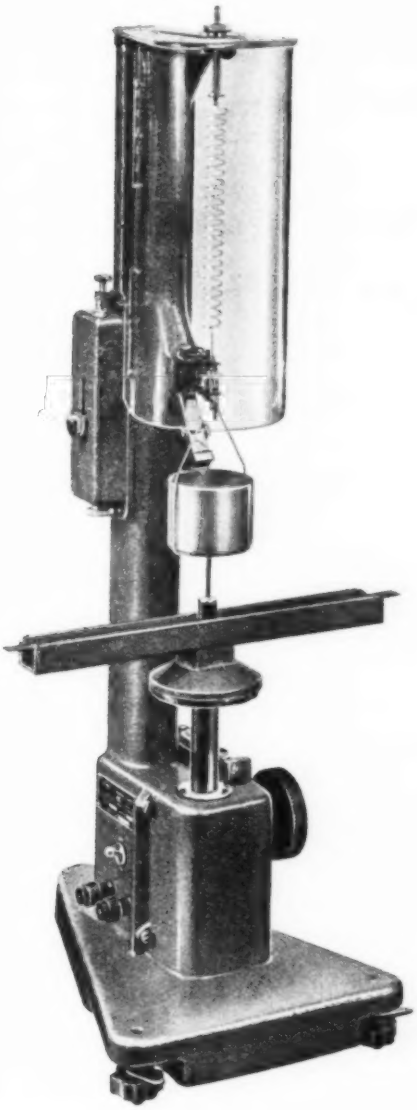

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APPOINTMENTS VACANT

UNIVERSITY COLLEGE, DUBLIN
I.C.I. RESEARCH FELLOWSHIPS

Applications are invited for I.C.I. Research Fellowships in Biochemistry, Chemistry or Physics, to which some appointments may be made during the current academic year. The appointments will date from October 1, 1961 (or earlier in the case of a selected candidate who may be available before that date) and will be for one year in the first instance; the maximum period of appointment is three years. The salary will depend upon qualifications and experience and will normally be within the range £800 to £1,100 per annum, together with family allowances.

Applicants should hold a Ph.D. or have equivalent research experience. Applications (three copies; from overseas one will suffice) should give age particulars of training, qualifications, research and other relative experience, a list of publications, an outline of the proposed field of research, and the names of two referees. Applications will be accepted up to March 7, 1961, by the undersigned, from whom a form (of which the use is optional) and other particulars may be obtained.

J. J. HOGAN,
Registrar.

UNIVERSITY OF NEW ENGLAND
ARMIDALE, NEW SOUTH WALES
DEMONSTRATOR IN AGRONOMY

Applications are invited for the above-mentioned position in the Department of Agronomy within the Faculty of Rural Science. The appointee will be required to demonstrate to laboratory classes in Plant Physiology and Soil Science and to assist with field work. Applicants should have a degree in science or agricultural science and will be expected to study for a higher degree. In this regard, tuition fees will be remitted for any course undertaken. The commencing wage will be fixed according to qualifications and experience, within one of the three grades of Demonstrators—Grade 1, £A.1,120 by £A.60 to £A.1,360 per annum; Grade 2, £A.1,320 by £A.80 to £A.1,560 per annum; Grade 3, £A.1,560 by £A.80 to £A.1,720 per annum. In addition, a cost of living allowance at present amounting to £A.29, is payable.

Applications should include age, marital status, academic qualifications and the names of two people to whom reference may be made. Applicants outside Australia and New Zealand should forward their applications to the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1, by February 15, 1961. An additional copy should be sent by air mail to the Registrar, University of New England, Armidale, N.S.W., Australia, to reach him by the same date. Applications from within Australia and New Zealand, should be forwarded directly to the Registrar by this date.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

Applications are invited from Physicists for a Lectureship in the Department of Meteorology. Previous knowledge of meteorology not essential, but interest in observational science desirable. The Department is primarily postgraduate and research facilities are good. Current experimental research is mainly in atmospheric turbulence, cloud physics and atmospheric infra-red spectrometry, and the person appointed would be expected to work initially in one of these fields or in atmospheric exploration using rockets and satellites. Salary scale £1,050 to £1,850 per annum plus £60 London allowance and family allowances, commencing salary depending upon experience.

Applications, with academic record, statement of research experience and interests, and names of two referees, should be sent to Professor of Meteorology, Imperial College of Science and Technology, London, S.W.7, not later than February 20, 1961.

QUEEN MARY COLLEGE
(UNIVERSITY OF LONDON)

Applications are invited for the post of Lecturer in Aeronautical Engineering tenable from October 1, 1961. The Lecturer will be required to assist in the teaching of Aerodynamics or Aircraft Structures and in the development of new equipment for laboratories now under construction. He will be encouraged to pursue his research interests. Salary scale £1,050 by £50 to £1,400 by £75 to £1,550 (efficiency bar); by £75 to £1,850, plus London allowance of £60, F.S.S.U. participation and family allowance of £50 for each child. Initial salary according to qualifications and experience.

Application forms, obtainable from the Registrar, Queen Mary College, Mile End Road, E.1, to be returned by February 20.

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Post "A." To study the nature of natural and artificially produced particles in the atmosphere, and to develop new methods of observation and measurement. The work involves the application of classical physics, and techniques such as electron microscopy, gamma spectrometry, and the use of radioactive tracers.

Post "B." To devise techniques for the experimental measurements of neutron flux and the spectral distribution of neutrons from reactors, particle accelerators and similar installations. Liaison with other branches of the U.K.A.E.A. and with universities will form part of the work.

Post "C." To join a small team working on the identification, localization and measurement of radioactivity in the human body, using gamma-ray spectrometry.

Post "D." To advise on the scientific aspects of the Health Physics service provided in scientific divisions. To direct the work of a small team of experimentalists and undertaking longer term and fundamental investigations arising from the work of Health Physicists.

PHYSICAL CHEMISTS are required for the following RESEARCH POSTS

Post "E." To study gas-solid interaction in aerosols, and gas-phase reactions at extremely low concentrations, involving the use of radioactive tracers and vacuum technique. A particular problem is the chemistry of both natural and radioactive iodine in the atmosphere, and its adsorption on sub-micron particles.

Post "F." To undertake laboratory physicochemical studies on the uptake of radio-nuclides by soil fractions and to assist in related field experiments, with particular reference to the fate of radioactive materials discharged to rivers.

Applicants should have at least a good second-class honours degree. Experience in handling radioactive material or measuring radioactivity would be an advantage. For appointment to the Senior Scientific Officer grade appropriate research experience required.

STARTING SALARY

According to age and experience within the following ranges:

Scientific Officer	**£755—£1,250 per annum.**
Senior Scientific Officer	**£1,365—£1,675 per annum.**

Housing and superannuation schemes. Send POST CARD for details to Personnel Manager, (1836/34) U.K.A.E.A., A.E.R.E. Harwell, Didcot, Berks.

PHYSICIST WITH ELECTRONIC, AND/OR instrument experience, and preferably at least honours degree, required for fundamental and applied research in a growing organization concerned with building materials.—Write for form of application to Box No. 937, T. G. Scott and Son, Ltd., 1 Clement's Inn, London, W.C.2.

SENIOR TECHNICIAN I REQUIRED FOR work in Bacteriological Division at Connaught Hospital, Walthamstow, E.17. Whitley Council salary and conditions.—Apply in writing, stating age, qualifications, experience and the names of two referees, to Secretary, Forest Group H.M.C., Langthorne Road, E.11.

COLLEGE OF AERONAUTICS

SENIOR LECTURER OR LECTURER IN WELDING TECHNOLOGY

A Senior Lecturer or Lecturer is required in the Department of Materials to undertake the detailed organization of a new postgraduate one-year course in Welding Technology, which will commence in October, 1961. The person appointed will be responsible for the major part of the teaching, but will be supported by the existing lecturing staff in metallurgy, in design and in production. The course will cover both the metallurgical and the engineering aspects of welding and is aimed at producing specialists in the subject for appointments in those industries where welding is now of major importance. Candidates will need to have high academic qualifications, preferably in metallurgy, coupled with practical experience of the techniques and the engineering utilization of welding. The salary scales are: Senior Lecturer, £1,900 by £75 to £2,425 per annum; Lecturer, £1,050 by £50 to £1,400 by £75 to £1,850 per annum; with superannuation under F.S.S.U. and family allowance. The commencing salary within the prescribed scale will depend upon age, qualifications and experience. Consideration given to housing requirements.

Applications, giving full particulars, and the names and addresses of three referees, should be forwarded to the Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks. Further particulars available.

UNIVERSITY COLLEGE OF RHODESIA AND NYASALAND

Applications are invited for a number of Research Fellowships in Departments of Botany and Agriculture. Salary scales: (A) Junior Research Fellow, £750 by £50 to £1,000 per annum. (B) Research Fellow, £1,200 by £50 to £1,400 per annum. (C) Senior Research Fellow, £1,500 by £50 to £1,700 per annum. (1) Plant Pathology (a) One in scale C in plant virology to investigate plant virus disease problems currently important in Central Africa. (b) Two in scale A in plant pathology to investigate fundamental problems in the pathology of major crops (excluding tobacco). (2) Soil Microbiology. Two in scales A, B, or C; one for non-symbiotic, the other for symbiotic nitrogen fixation studies. (3) Pasture Ecology. Two in scales A, B, or C; one in agrostology on establishment of grasses in sown pastures, and one in plant ecology on improvement and maintenance of pastures. (4) Animal Science. One in scale B or C, on rumen microorganisms and low nutritional environment of ruminants. Applicants must have good honours degrees and for appointment to the higher scales considerable research experience is required. Superannuation and Medical Aid Schemes. Return passage to Salisbury for appointee. Housing allowance of £100 per annum, if unfurnished accommodation at 15 per cent of salary is not provided.

Detailed applications (six copies), naming three referees, by February 28, 1961, to Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1, from whom further particulars may be obtained.

RADIO AND UPPER ATMOSPHERE RESEARCH

Physicists, Engineers and Mathematicians required by D.S.I.R. at Radio Research Station, Ditton Park, Slough, as Scientific Officers or Senior Scientific Officers to investigate the upper atmosphere and the space between the earth and sun, with particular reference to the propagation of radio waves through those regions, and associated problems of terrestrial and space communications. Work concerned with experiments on ground, and in rockets and satellites. On experimental side it involves the design and use of suitable radio equipment including low noise amplifiers for use with radio telescope; research on cosmic rays, vacuum physics, and spectroscopy. For theoretical studies knowledge of magnetohydrodynamics or of plasma physics will be useful. Digital computer is available for the study of orbits of artificial satellites. Qualifications: first- or second-honours degree or equivalent in physics, electrical engineering, or mathematics, with at least three years postgraduate experience for Senior Scientific Officer grade. Salary ranges Scientific Officer, £690 to £1,144; Senior Scientific Officer, £1,250 to £1,540. Normal promotion prospects to Principal Scientific Officer in the mid-thirties (range of £1,600 to £2,275).

Forms from Ministry of Labour, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.581/OA.

PA

PERSONNEL ADMINISTRATION LIMITED

MANAGEMENT CONSULTANTS

AUSTRALIAN WOOL BUREAU

Technical Manager

The Bureau has recently set up in Melbourne a department to encourage and hasten the introduction of new technical developments and processes in the industry. The Technical Manager, who must be a University qualified scientist with wool manufacturing experience, will be required

(a) to evaluate scientific developments for wool and to assist manufacturers to introduce them,

(b) to maintain contact with wool research workers in Australia and overseas in order to keep the Bureau informed of research progress,

(c) to collaborate with wool scientific workers in determining which aspects of wool research should receive major emphasis,

(d) to provide a technical information service to the Bureau and manufacturers,

(e) to train and manage the staff of the Technical Department.

Salary will be up to £A.4,000; removal expenses to Melbourne for appointee and his family; generous superannuation benefits.
(Ref. 1541/NA)

The identities of candidates will not be revealed to our clients without prior permission. Applicants should forward brief details, quoting the reference number, to:

PERSONNEL ADMINISTRATION LIMITED,
Appointments Division, 2, Albert Gate, London, S.W.1.

Regional Offices: GLASGOW · MANCHESTER · BRISTOL · BIRMINGHAM · DUBLIN · LEEDS · NEWCASTLE

UNIVERSITY OF CAMBRIDGE

OBSERVATORIES

Applications are invited for a post of Senior Assistant Observer. Candidates should have a good honours degree in mathematics, physics or astronomy, and some experience of research in astrophysics. University stipends are under review. The expected salary scale is £1,050 by £50 to £1,400 by £75 to £1,800. A suitably qualified candidate may be given some seniority on appointment. F.S.S.U. Children's allowance £50 per child under 16 or receiving full-time education.

Applications, with the names of three referees, should be sent to the Director, Observatories, Madingley Road, Cambridge, from whom further particulars may be obtained. Closing date February 15.

UNIVERSITY OF CAMBRIDGE

OBSERVATORIES

Applications are invited for a post of Technical Officer. Candidates should have a degree in physics or engineering and good practical knowledge of electronics. Duties: research into photoelectric photometry by pulse counting techniques. Proposed salary scale: £1,050 by £50 to £1,400; F.S.S.U. Children's allowances £50 per child.

Applications, with the names of three referees, should be sent to the Director, Observatories, Madingley Road, Cambridge, from whom further particulars may be obtained. Closing date February 15.

UNIVERSITY OF LEEDS

SCHOOL OF CHEMISTRY

Applications are invited for appointment as Assistant Lecturer in Physical Chemistry at a salary within the range £800 to £950 a year, according to age, qualifications and experience. Preference will be given to candidates skilled in or possessing a knowledge of mass spectrometry as applied to chemical problems.

Applications (three copies), stating date of birth, qualifications and experience, together with the names of three referees, should reach the Registrar, The University, Leeds, 2 (from whom further particulars may be obtained) not later than February 14, 1961.

McMASTER UNIVERSITY

GRADUATE ASSISTANTSHIPS IN CHEMISTRY

Applications are invited for Assistantships from persons qualified to pursue M.Sc. and Ph.D. work in Chemistry. Assistantships carry a yearly stipend of $2,200 to $2,800 and require eight to twelve hours per week of assisting from September to April only. The Department has excellent research facilities and provides opportunities for research in most branches of chemistry.

Further information concerning assistantships, scholarships and research in progress in the Department may be obtained from D. B. MacLean, Chairman, Department of Chemistry, McMaster University, Hamilton, Ontario, Canada.

AUSTRALIA

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

FELLOWSHIP IN SURFACE CHEMISTRY

(No. 370/136)

The Organization's **Division of Tribophysics** located at Melbourne University, Parkville, Victoria, invites applications for a Fellowship in Surface Chemistry from Honours graduates in Chemistry with postgraduate research experience. The surface chemistry group is concerned with the way in which the state of a solid surface affects its chemical properties such as absorption, and catalysis. Other research groups have extensive experience in Crystal defects and their relationship to physical properties and similar ideas are being applied to the chemical behaviour of solid surfaces.

Salary: Dependent on qualifications and experience, commencing salary will be not less than £A.1,620 up to a maximum of £A.2,265 per annum.

The Fellowship will be initially for a period of three years.

RESEARCH ENGINEER/PHYSICIST

(No. 750/188)

The Organization's **Division of Metrology, National Standards Laboratory, Sydney,** invites applications from Honours graduates in Engineering or Science, with Physics as a major subject and post-graduate experience in one of the under-mentioned fields.

As one of the three Divisions comprising the National Standards Laboratory, it is concerned with the maintenance of standards for length, mass, and related matters. The appointee must be capable of initiating research into, and development of, new and improved measuring techniques and equipment in engineering metrology; particularly in large scale metrology, dynamic metrology, and gears and gear-cutting equipment.

Salary: Dependent on qualifications and experience within the ranges: £A.1,510 to £A.2,265 per annum, or £A.2,395 to £A.2,720 per annum.

Salary for women will be £A.180 per annum less than corresponding rates for men.

Promotion within C.S.I.R.O. is by merit and may ultimately go beyond the upper limit of the range within which the original appointment is made.

Fares paid. Further details of conditions, etc., supplied on application to:

Mr. E. J. Drake, Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2,

to whom applications (quoting relevant Appointment number) should be addressed by March 4, 1961.

SCIENTIFIC OFFICER FOR INDIA

This is a new and important appointment for an Indian subject in a major Indian Company. The selected candidate should have obtained a university degree with honours, preferably a first in chemistry, and have had about ten years' research and industrial experience in physical chemistry. Some of this experience should have been in the United Kingdom or the U.S.A.

The duties will include:

Liaison with the Research and Development work conducted by the Parent Company in the United Kingdom.

Studying new industrial developments which may be relevant to the operations of the Indian Company. Advising on the scientific standards of the Company's Laboratories in India.

Keeping in touch with Indian scientific establishments.

Applications to be addressed to Box 945, T. G. Scott and Son, Ltd., 1 Clement's Inn, London, W.C.2.

MEDICAL RESEARCH COUNCIL/ WORLD HEALTH ORGANIZATION /INDIAN GOVERNMENT

TUBERCULOSIS CHEMOTHERAPY CENTRE, MADRAS

VACANCY FOR A BACTERIOLOGIST

The Medical Research Council, on behalf of the World Health Organization, wish to fill a vacancy for a Bacteriologist at the Centre, in the Autumn of 1961. The Centre, for which the Council have scientific responsibility, was started in 1956, and is in a fully productive state of research development; a number of reports have been published or are in the press. It has a well-equipped laboratory, occupied in the bacteriological diagnosis of tuberculosis, the culture and identification of acid-fast organisms, and the investigation of bacterial sensitivity to the drugs under study. A variety of other research programmes is in operation. The successful candidate will be expected to participate fully in the planning and execution of the research programmes, and the drafting of reports. He must be prepared to do some postgraduate training. Medical qualification or university degree in bacteriology is required, with experience of running a laboratory and particular experience in tuberculosis work. The successful candidate must have initiative and the energy to work under tropical conditions. He will be working in close co-operation with Indian colleagues. The successful candidate will be employed by W.H.O. by contract for two years, possibly extendable. Salary $7,300 per year income tax-free under the usual W.H.O. arrangements, plus assignment allowance ($950 per year without dependants and $1,200 per year with dependants), post adjustment allowance ($270 per year without and $400 per year with dependants), dependant's allowance ($200 per year for a wife, $300 per year for a child) and various other installation allowances, educational grants and service benefit on termination (8 per cent of salary per year), all tax-free. First-class air passages for successful applicant and dependants to India and back. Appointment, from Autumn of 1961, will probably include initial training in London. It may be possible to arrange for the secondment of the successful candidate if he is at present employed by the National Health Service or the Medical Research Council. Indian Nationals are ineligible for this post under W.H.O. regulations.

Applications (two copies), giving age, qualifications, details of experience, and the names of three professional referees, should be sent to the Secretary (A.D.5), Medical Research Council, 38 Old Queen Street, Westminster, London, S.W.1, as soon as possible. Candidates placed on the short list will be asked to fill up World Health Organization questionnaires.

NEW ZEALAND

AGRICULTURE DEPARTMENT

Applications are invited for the undermentioned vacancy: No. 1261—Scientific Officer, Levin, Agriculture Department, New Zealand. Duties: Study the water requirements of horticulture crops and the equipment, methods and times of water application. To initiate and assist in carrying out experimental work associated with the irrigation of crops. There will also be an opportunity to take an interest in the methods and economics of glasshouse heating. Qualifications desired: A degree in science or agricultural science. Some experience of horticultural production an advantage. Salary up to £1,120 a year dependent upon qualifications and experience. Promotion above £1,120 is on scientific merit. An outstanding officer could rise to £2,025 a year. Passages: Steamer fares of up to £165 each for the appointee and his wife, and pro rata for dependent children will be paid. Incidental expenses: Up to £35 for a single person and £100 for a married man can be claimed to cover the cost of taking personal effects to New Zealand.

Inquiries quoting reference number B11/2/40, should be addressed to the High Commissioner for New Zealand, 415 Strand, London, W.C.2, who will furnish further details and application forms. Completed applications to be lodged with this office not later than March 3, 1961.

RESEARCH WORKER, BIOCHEMIST OR chemical pharmacologist, preferably with Ph.D. or equivalent experience, required to investigate the biochemical actions of drugs currently used in the treatment of mental illness. Spectrophotofluorimetric methods of analysis will be employed. The work will be carried out in conjunction with clinical studies on therapeutic action. Three-year appointment, commencing salary £850 to £1,100 depending on qualifications and experience.—Applications, with names of two referees, to Director of Clinical Research, Crichton Royal, Dumfries, from whom further details may be obtained.

POSTDOCTORATE FELLOWSHIPS IN CHEMISTRY

The Research Council of Alberta, with laboratories adjacent to the campus of the University of Alberta, intends to award three fellowships for fundamental research in chemistry. Applicants should have, or expect to have, a Ph.D. or equivalent degree before taking up the award. There are no restrictions regarding nationality of applicants but candidates must meet Canadian immigration requirements. Fellowships will be awarded on a one-year basis with a maximum tenure of two years. Appointments may be taken up at any time during the year, but spring or early summer is preferred. The annual stipend of $4,000 for single, and $5,000 for married male fellows is income tax free. A travel allowance will also be provided. Fellowships are available in the following fields: Sorption and Catalysis on Alumino-Silicates; Studies on Free Radicals produced by Single Electron Oxidation-Reduction Processes using E.P.R. techniques; Kinetic Isotope Effects in Gas Phase Reactions; Photochemistry.

Inquiries and a brief statement of interests and experience should be addressed to the Secretary, Research Council of Alberta, Edmonton, Alberta.

UNIVERSITY OF ST. ANDREWS

Applications are invited for the following posts in the Department of Botany, Queen's College, Dundee, commencing October 1, 1961:

Lectureship: Honours Degree in Botany or Agricultural Botany with postgraduate research and training in Plant Pathology—interest in Host-parasite relations desirable. Salary scale: £1,050 by £50 to £1,400 (efficiency bar) by £75 to £1,850. Grant towards furniture removal expenses.

Assistantship: Honours Degree in Botany or Agricultural Botany with training in Plant Pathology—interest in Virus Diseases desirable. Salary scale: £800 by £50 to £950. Three years appointment, with possibility of fourth and final year.

For both posts, F.S.S.U., Family Allowance. Applications, in each case (six copies), with names of three referees, to the undernoted, from whom further particulars may be obtained, not later than March 11, 1961.

PATRICK CUMMING,
Joint Clerk to the University Court.
Queen's College, Dundee.

ESSEX

MID-ESSEX TECHNICAL COLLEGE AND SCHOOL OF ART
MARKET ROAD, CHELMSFORD

Assistant Grade B in Chemistry required from May 1 or September 1, 1961, capable of taking classes to B.Sc. (General) degree and H.N.C. level. Applicants should be graduates, preferably with teaching experience or teacher training. Research and/or industrial experience would be an advantage. Applicants should indicate the branch of chemistry for which they have a preference. Salary scale: £700 rising to £1,150 per annum plus additions for training and graduate qualifications if in accordance with the Burnham Further Education Report, 1959). The commencing salary will have regard to war/national service, previous experience in teaching and/or industry or research.

Details and forms from the Clerk to the Governors at the College, to whom completed forms should be returned as soon as possible.

THE SCIENTIFIC CIVIL SERVICE NEEDS men and women for pensionable posts as (a) Senior Scientific Officers, and (b) Scientific Officers in all major scientific fields, including Physics, Engineering, Chemistry, Meteorology, Mathematics, and Biological subjects. Some particular vacancies include Physicists/Electrical Engineers for research in the application of servo-control for machine tools, Physical Chemists, Chemists for research in high polymers, post at Army Operational Research Group for Scientists in most disciplines, Mineralogist to work on Meteorites (Petrologist with sound knowledge of Physics preferred), and Zoologists to specialize in the taxonomy of the Porifera. Qualifications: Normally a degree, or a Diploma in Technology, with first- or second-class honours in science, mathematics or engineering, or equivalent attainment; additionally, for (a), at least three years' relevant postgraduate experience. Normal age limits: (a) between 26 and 32, (b) between 21 and 29, with extension for regular Forces service and Overseas Civil Service. Selection by interview. London salaries: (a) £1,382 to £1,704, (b) £759 to £1,258, provision for starting pay above minimum. Promotion prospects.—Write Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting (a) **S/53/61**, (b) **S/52/61**.

DECCA RADAR

OPERATIONAL RESEARCH LEADER

An enterprising leader is wanted for the Company's Operational Research Team. Decca Radar Limited recognizes the substantial contribution operational research can make to the conduct of a large electronic business, particularly one which is exploring the frontiers of technology.

An experienced team of nine highly qualified graduates work in close liaison with the Decca Radar Research and Development Laboratories. Their work embraces a very wide range of radar systems and data handling problems—for example, the application of automation techniques to air defence, air traffic control and airborne navigational systems. Considerable pioneer work is being done on automation of radar data processing involving highly advanced methods of real-time computer control. The prospective leader should have a sound knowledge of mathematics, a good grasp of engineering and operational research methods, and a flair for guiding a team of scientists towards practical proposals.

He will be expected to extend the present work and also give a decisive lead to other studies concerned with meteorological data-processing, marine navigation, satellite tracking.

This is a first-class opportunity for a man of suitable calibre to play a determining part with one of the world's leading electronic companies.

Applications should be made direct to the Managing Director, DECCA RADAR LIMITED, 9 Albert Embankment, London, S.E.11.

Senior Biological and Research Positions

with the

CANADIAN DEPARTMENT OF AGRICULTURE

SALARIES: $8,120 to $11,200 PER ANNUM

ANIMAL GENETICIST—To undertake research in quantitative genetics with the ultimate objective of obtaining basic information needed for an understanding of inheritance of economic traits in livestock and poultry.

FOREST BIOLOGIST—Plant or Forest Pathologist to design, conduct, and supervise research in diseases of forest nursery stock.

QUANTITATIVE GENETICIST—Mathematician or Statistician to conduct research into methods appropriate for dealing with problems in quantitative genetics.

Inquiries are invited from persons with a number of years of productive research experience and appropriate training to the Ph.D. level or equivalent. Details of education, experience, publications and research projects should be attached. Reference 61-2201 should be quoted. Direct inquiries to:

CIVIL SERVICE COMMISSION OF CANADA, OTTAWA, ONTARIO.
Attention: Functional Division.

UNITED KINGDOM TECHNICAL ASSISTANCE

Applications are invited for an appointment as expert in the Standardization of Veterinary biologicals at the Pakistan Animal Husbandry Institute, Peshawar, Pakistan. Applicant must have had at least 10 years practical experience of standardization of biologicals in Government Institute or a firm particularly dealing with products required for the control of Rinderpest, Haemorrhagic Septicaemia, Anthrax, Newcastle, Black Quarter, etc. Age about 40 years. One year contract in first instance. Salary £2,500 per annum, plus generous tax free allowances.

For further information and application form write to Ministry of Labour (E.9), 26 King Street, London, S.W.1, quoting E9/TCS/PAK/891.

HEAD OF DEPARTMENT OF SCIENCE

Required at Cambridgeshire Technical College and School of Art on September 1, 1961. The Department provides full-time and part-time courses up to Final Degree standard in Mathematics, Physics, Chemistry, Botany, Zoology and Geology. Candidates should have good academic qualifications in science. Teaching, industrial and administrative experience are also very desirable, but candidates without these qualifications who appear suitable will be considered. Grade IV Head of Department salary scale: £1,950 by £50 to £2,100.

Full particulars and forms of application from the Principal, Cambridgeshire Technical College and School of Art, Collier Road, Cambridge.

THE CAMEROONS DEVELOPMENT CORPORATION

requires in its

RESEARCH DEPARTMENT

Soil Scientist

Applicants should be fully qualified soil scientists having an Honours degree in chemistry or agricultural science, or equivalent qualifications with appropriate post-graduate training and experience preferably in tropical soils. Preference will be given to applicants with experience of soil survey work (including interpretation of aerial photographs) and interpretation of foliar analysis.

This post offers considerable scope for interesting work and for personal advancement. The Corporation has large estates in the Southern Cameroons, the main crops being oil palms, rubber, cocoa, bananas and tea. Candidates should be between the ages of 25 and 35 years. Tours will normally be of approximately 18 months with liberal leave on full pay. Free passages are provided to and from the Cameroons for officers and their families, together with free furnished accommodation during residence in the Cameroons. A reasonable amount of free lighting and fuel is also provided, and necessary transport. An outfit allowance of £80 is payable on first appointment; children's allowances are payable up to a maximum of two at the rate of £75 each. Officers are required to contribute 10 per cent of their salary to a Provident Fund, the Corporation contributing 15 per cent.

Applicants should send personal particulars to the

Personnel Officer, Colonial Development Corporation, 33 Hill Street, London, W.1, quoting Serial No. 459.

CHIEF PHYSICIST

required by **Cambridge Instrument Co. Ltd.**, *due to expansion of the Physics Section of the Research Department, housed in well-equipped modern Laboratories in the pleasant University City of Cambridge.*

THE MAN He will be a mature and experienced Physicist with a broad base of classical physics and some industrial experience, rather than a specialist in any one field. Ph.D. desirable, but this does not preclude from consideration the man with a good honours degree and appropriate experience.

THE JOB Responsibility for administration of the Physics Laboratory, which will have sections led by Senior Physicists with Graduates and non-Graduate Assistants working on classical physics, electronics, process control, and if experience is suitable *X*-ray microanalysis.

SALARY & PROSPECTS The ***prime factor*** is finding the right man who can expect the usual benefits; a very adequate salary, with excellent opportunities and Company backing to develop his own particular interests in the broadest fields of physics. Housing assistance for the successful candidate if required.

Write in confidence, giving details of age, experience and qualifications to

Dr. M. C. Marsh,

CAMBRIDGE INSTRUMENT CO. LTD.

CHESTERTON ROAD CAMBRIDGE

RESEARCH FELLOWSHIPS

(3 years) in

GOVERNMENT SCIENTIFIC ESTABLISHMENTS

Value £1,275 to £1,575 per annum (Senior), and £875 to £1,175 per annum (Junior). A very wide range of topics, especially in the Physical Sciences; also several vacancies in various branches of Biology. Qualifications: Normally first- or second-class honours degree; evidence of high standard of ability in research; and at least two years' post-graduate research experience (three years for Senior Fellowships). Those completing these periods of experience in 1961 may apply. F.S.S.U.

Write Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting **S/5244/61.**

MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

(Faculty of Technology in the University of Manchester)

Applications are invited for two Assistant Lectureships in Biochemistry in the College with corresponding title and status in the University of Manchester. Research interests in the Department of Biochemistry, which has recently been reorganized, cover various aspects of animal, plant and microbiological biochemistry. Salary in the scale £800 by £50 to £950 with F.S.S.U. and family allowances.

Further particulars and application form may be obtained from the Registrar, the Manchester College of Science and Technology, Manchester, 1, to whom completed applications should be returned by Saturday, February 25, 1961.

LINCOLNSHIRE RADIOTHERAPY CENTRE

Applications are invited for the post of Physicist from Graduates with some years' postgraduate experience in Hospital Physics or closely allied work. Experience in electronics will be a strong recommendation. The post will be in the Senior Grade. The new Physics Department is now being established at St. George's Hospital, in connection with the new Radiotherapy Centre at Lincoln. There will be good facilities for work with modern radiotherapy equipment, radioactive isotopes and in general medical physics. The transfer of the Lincolnshire Radiotherapy Centre from Scunthorpe to Lincoln will be completed by June, 1961. The successful candidate will assist in the transfer and the establishment of the new department. The salary is according to the Whitley Council Scale.

Applications, giving details of qualifications and experience, together with the names of two referees, should be addressed to the Group Secretary, Lincoln No. 1 Hospital Management Committee, County Hospital, Lincoln, from whom further particulars can be obtained.

LEEDS REGIONAL HOSPITAL BOARD

REGIONAL PHYSICS UNIT

Applications are invited for the appointment of a Hospital Physicist for duties with the Regional Physics Unit whose Headquarters are at Cookridge Hospital, Leeds. The post will be either in the basic or senior grade according to experience. The work is mainly concerned with the treatment of disease by High Energy Units but opportunities also exist for work with radioisotopes and co-operation with medical staff on other physical problems. Candidates should possess an appropriate honours degree and for appointment to the Basic Grade need have had no previous experience but for the Senior Grade not less than five years' experience as a Hospital Physicist is required. New entrants in the Basic Grade will be required to undergo a probationary period of at least two years. Salary scales: Basic Grade Probationary, £730 to £925 per annum, Post-probationary, £925 to £1,150 per annum. Senior Grade, £1,250 to £1,700 per annum.

Applications, stating age, qualifications, experience and details of present and previous appointments, together with dates and the names and addresses of two referees, to the Secretary, Park Parade, Harrogate, by not later than February 8, 1961.

SOUTH-EAST ESSEX TECHNICAL COLLEGE AND SCHOOL OF ART

LONGBRIDGE ROAD, DAGENHAM

Required as soon as possible: Grade "B" Assistant Lecturer in Chemistry to specialize in one branch of chemistry to Grad.R.I.C. and B.Sc. General standard. Applicants should have a good honours degree or equivalent, with some teaching and/or industrial experience, and an interest in research. Salary within scale £700 to £1,150 per annum, depending on previous experience. Additions to scale for training and graduate qualifications if in accordance with Burnham Further Education Report conditions. London Allowance of £38 or £51 per annum also payable. Increments within the scale will be allowed for previous relevant experience and war service.

Details and application forms from the Clerk to the Governors at the College.

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING

(UNIVERSITY OF READING)

A post is available for a physiologist or zoologist, with interests and experience in the field of mammalian reproduction, in a small unit investigating the biochemical and physiological properties of cervical secretions, with particular reference to fertility. The work envisaged will involve a study, in co-operation with two biochemical colleagues, of the metabolism, motility and fertility of spermatozoa in cervical mucus and in fractions which can be separated from it. Good research facilities are available and the post offers an attractive opportunity for a scientist who wishes to work in a field bearing on this highly significant problem. The candidate will be expected to initiate and carry out work on the physiological side of the investigation. Applicants should have a good degree in zoology or physiology preferably with Ph.D. Appointment would be for three years in the first instance, salary in accordance with experience and qualifications.

Applications to the Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks, quoting ref. 61/2.

CIVIL ENGINEERS FOR DEPARTMENT OF MAIN ROADS
NEW SOUTH WALES, AUSTRALIA

Applications are invited from graduates (or undergraduates in their final year) in Civil Engineering of a recognized British or Irish university for appointment to the staff of the Department of Main Roads, New South Wales, the State Road Authority for construction of roads and bridges. On appointment applicants may be engaged at the Department's Head Office, Sydney, on the design of reinforced concrete and steel bridges, or on main road constructions and maintenance either in the Metropolitan Area or the country. Commencing salary according to qualifications and experience will be within the range £A.1,325 to £A.1,650 per annum, with annual progression, subject to technical competence, to £A.2,400 per annum. Appointees will be eligible to contribute to the State Superannuation Fund after six months. Appointee's full fare from England to Australia will be met by the Department, subject to a three years' service guarantee bond being completed. Appointment will be subject to passing a medical examination, and preference will be given to applicants not more than 30 years of age.

Applications should be made on forms obtainable from the Agent-General for New South Wales, 56 Strand, London, W.C.2. Please quote No. 44/31 when writing.

WREXHAM, POWYS AND MAWDDACH HOSPITAL MANAGEMENT COMMITTEE

Applications are invited for the post of Hospital Biochemist (Senior Grade), to take charge of a newly built Department of Biochemistry at the Group Laboratory, Maelor General Hospital, Wrexham. Salary scale will be according to the new Whitley Council rates, i.e., £1,250 to £1,700 per annum.

Candidates with appropriate qualifications and experience should apply, giving full details of previous employment and the names of three referees to the undersigned by January 31, 1961.

WILLIAM JONES,
Group Secretary.

Maelor General Hospital,
Croesnewydd Road,
Wrexham, Denbighshire.

ROYAL AIRCRAFT ESTABLISHMENT, Farnborough requires Physicists and Mechanical, Electrical and Electronic Engineers with first- or second-class honours degree, or equivalent, and having sound fundamental background and skill in experimental techniques, for research in rapidly expanding important and challenging field of inertial Navigation. Posts in sections concerned with electrical and electronic problems of measurement, control, analogue and digital computing, and research into new methods of producing an inertial space reference. Salary range: £690 to £1,540 (Scientific and Senior Scientific Officers), grade and starting salary according to age, qualifications and experience. Yearly increments. Unestablished posts, with superannuation under F.S.S.U. Opportunities to compete if of suitable age for established post, pensionable under the Superannuation Acts.—Forms from Ministry of Labour, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.579/GA.

MATHEMATICIANS REQUIRED IN Research and Development Establishments, of War Office. Feltham, Middx. Mathematical solution of land survey problems with aid of Pegasus Electronic Computer (knowledge of geodesy or land survey an advantage). Farnborough, Hants, and Shoeburyness, Essex. Statisticians (a) with experience in biological work, or (b) in instrumentation. Sevenoaks, Kent. (a) Advanced programming techniques for digital and analogue computers, (b) Assessments of weapon effectiveness, (c) Fluid or theoretical solid mechanics. Anglesey, N. Wales, mathematical and statistical problems in artillery range work; review of techniques and instruments for analysis of trials; instruments and methods of recording. Appointments in grades of (i) Senior Scientific Officer, £1,250 to £1,540, or (ii) Scientific Officer, £690 to £1,144. Starting salary according to experience. Superannuation under F.S.S.U., with opportunities for candidates under 31 to compete for established (pensionable) posts. First- or second-class honours degree required, and for (i) minimum age 27 and at least three years post-graduate research experience.—Forms from Ministry of Labour, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.558/GA.

Parasitologist

A vacancy has occurred for a qualified Parasitologist to join a research team in Sandwich, working on an interesting range of veterinary activities.

The post calls for a man, preferably with industrial experience and desirably—but not essentially—with a veterinary qualification. He should be experienced in helminthology and anthelmintics, and a knowledge of helminth immunity would be an advantage. Preferred age range 24 to 30.

Conditions of service are of a high standard and include generous non-contributory pension and life assurance schemes. The salary will be attractive. Living areas within reasonable distance of the Sandwich Plant include the Kent coast and Canterbury etc. Removal expenses will be paid and assistance may be provided for house purchase.

Applications are invited; they should be addressed to

THE CHIEF PERSONNEL OFFICER,
PFIZER LIMITED, SANDWICH, KENT

THE Pfizer GROUP
CHEMICALS PHARMACEUTICALS VACCINES
AGRICULTURAL & VETERINARY PRODUCTS

OLDCHURCH HOSPITAL ROMFORD, ESSEX
(709 Beds)
RADIOTHERAPY DEPARTMENT

Senior Technician or Technician required for the above Department. Duties include Physics Workshop, Isotope Laboratory, Radium and Mould Room work. Instrument or Physics Workshop experience essential. Salary £570 to £710 per annum; senior grade, £710 to £905 per annum would be applicable to suitably qualified person.

Applications, quoting Ref. 17/39, giving full details, including age and experience, together with names of two referees and/or copy of testimonials to the Group Secretary, Romford H.M.C., Oldchurch Road, Romford.

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING
(UNIVERSITY OF READING)

Honours graduate in chemistry or biochemistry required in Radiobiochemistry Department for biochemical research involving the use of radioactive isotopes and in particular C^{14} and tritium. The appointment will be made in the grade of Scientific Officer (£717 to £1,222) or of Senior Scientific Officer (£1,302 to £1,654) at a salary commensurate with experience and qualifications; F.S.S.U. Facilities exist to register for higher degree.

Applications, naming two referees, to the Secretary, N.I.R.D., Shinfield, Reading. Quote ref. 61/1.

NORTHERN REGIONAL HOSPITAL BOARD (SCOTLAND)

Applications are invited from Science Graduates for a post of Non-Medical Assistant Biochemist in the Board's Regional Laboratory Service at the Royal Northern Infirmary, Inverness. The post is in the basic grade and the salary during the probationary period is £650 by £25 (2) to £700 by £30 (4) to £820 by £35 (3) to £925, and after the probationary period £925 by £35 (2) to £995 by £40 (3) to £1,115 by £35 to £1,150.

Further particulars and application forms are obtainable from the undersigned with whom applications should be lodged by February 13, 1961.

A. M. FRASER, M.D.,
Secretary and Administrative Medical Officer.

Reay House,
17 Old Edinburgh Road,
Inverness.

ADVISORY OFFICERS

Thornber Brothers Limited wish to extend their advisory service. Applications are invited from men with a degree qualification and a knowledge of the poultry industry. Successful applicants will be responsible for the company's advisory activities in one of the sales areas and will work in co-operation with, but independently of the sales supervisor. Advisory officers will be in close contact with the head office at Mytholmroyd and directly responsible to the Chief Advisory Officer. Extensive library and reprint facilities are available, also the advisory officers will be expected to be on good terms with all the centres of agricultural education in their areas. These are permanent responsible positions and salaries will be paid accordingly.

Applications in writing to The Chief Advisory Officer, Research Division, Thornber Brothers Limited, Mytholmroyd, Halifax, Yorkshire.

UNIVERSITY OF EXETER

Applications are invited for an I.C.I. Research Fellowship in Chemistry and Physics, to which appointment may be made during the current academic year. The appointment will date from October 1, 1961, and will normally be made for three years. The salary will depend upon qualifications and experience, but will be within the range £800 to £1,100 per annum, together with children's allowances and membership of F.S.S.U.—Applications (six copies), with a list of publications and the names of two referees, should be sent, not later than March 5, 1961, to the Secretary, from whom further particulars may be obtained.

COMMONWEALTH AGRICULTURAL BUREAUX

The Executive Council invites applications for the post of: Assistant Director, Bureau of Animal Breeding and Genetics, King's Buildings, West Mains Road, Edinburgh 9, Scotland. Candidates should have a good science degree, preferably with some knowledge of genetics and/or statistics. They should also have a knowledge of at least two foreign languages. Salary £1,650 to £2,325 with provision for superannuation. Starting point depends on age, qualifications and experience.

Applications should be submitted by March 31, 1961, to: The Secretary, Commonwealth Agricultural Bureaux, Farnham House, Farnham Royal, Bucks, England, from whom further particulars, including passage regulations, can be obtained.

AEI

Associated Electrical Industries Limited

INSTRUMENTATION DIVISION

NUCLEAR MAGNETIC RESONANCE

The Scientific Apparatus Sales Department of A.E.I. Instrumentation Division require a CHEMIST or PHYSICIST for applications work in Nuclear Magnetic Resonance and allied techniques. This is interesting work in a new and expanding field. Spectroscopic experience in other fields would be an advantage. Training in the NMR field would be given. Please write for application form quoting reference S.17 to :

Personnel Manager,
Associated Electrical Industries (Manchester) Ltd.
Trafford Park, Manchester, 17

A LENS DESIGNER

is required by

THE TAYLOR, TAYLOR AND HOBSON DIVISION OF RANK PRECISION INDUSTRIES LIMITED

to work on development of specialized optical systems for photography and television. The ideal applicant will have been responsible for some original design work in these fields, although less experienced applicants having suitable qualifications will be considered.

Salary offered will be commensurate with experience.

All applications, which will be treated in strict confidence, should be addressed to

THE TECHNICAL DIRECTOR,
TAYLOR, TAYLOR AND HOBSON,
STOUGHTON STREET WORKS,
LEICESTER.

THE GAS COUNCIL

Head of Basic Research Group

has decided to establish a new Group to undertake long-range research projects of potential value to the future development of the gas industry. Applications are now invited for the appointment of head of this Group.

The post will afford exceptional opportunity for original research; the person appointed will be in charge of the Group, the work of which will form part of the Council's research programme. In originating and carrying out projects, he will be directly responsible to the Research Committee of the Gas Council, and he will be encouraged to display originality and initiative.

The new Basic Research Group will be located in the Gas Council's London Research Station at Fulham.

Candidates, who should have post-graduate qualifications, must be able to submit evidence of first-class ability in original research. They should have a keen interest in the applications of research to industry, and should preferably have had some industrial experience. The fresh outlook and drive needed to create and direct this group may well be found in a relatively young man. A salary in the region of £3,000 p.a. is envisaged.

Further particulars of the appointment are obtainable from The Secretary, The Gas Council, 1, Grosvenor Place, London, SW1 to whom applications, which will be treated in the strictest confidence, should be sent by 24th February, 1961.

CHEMIST

NYASALAND

Qualifications: Applicants must possess first- or good second-class honours degree in chemistry, or an equivalent qualification. Experience in the inorganic analytical field and a knowledge of geochemical techniques would be an advantage.

Age: 21 to 35.

Duties: To take charge of Geological Survey Department's chemical laboratory and to undertake assaying and chemical testing of rocks, including full silicate rock analyses.

Terms: On contract for one tour of two to three years in the first instance with gratuity payable on satisfactory completion. Salary, according to experience in the scale £1,145 to £1,950. Free passages. Quarters at rental if available. Generous leave.

Apply to Director of Recruitment, Colonial Office, London, S.W.1, stating full name, age, qualifications and experience, and quoting BCD.105/4/04/C1.

NOTTINGHAM UNIVERSITY

Applications are invited for the following appointments which will be made to the staff from October 1, 1961 (unless otherwise stated): Reader in Pharmacology (September 1, 1961). Lecturer in Sociology. Tutor in Primary Education. Lecturer in Organic Chemistry. Lecturer in Food Science (September, 1961). Lecturer in Agriculture (Animal Production) (June, 1961). Lecturers and Assistant Lecturers in: (a) Civil Engineering; (b) Electrical Engineering. Assistant Lecturers in: (a) French; (b) Theology; (c) Applied Mathematics; (d) Botany. Salary scales: Reader, £1,850 to £2,425; Lecturer, £1,050 to £1,850; Assistant Lecturer, £800 to £950; initial salary in each case according to qualifications and experience. Membership of F.S.S.U. and children's allowance.

Conditions of appointment and form of application, to be returned by February 18, from the Registrar.

GRADUATES REQUIRED, PREFERABLY with experience in research on free radicals, photochemistry, semi-conductors or allied fields to join research team; also assistant chemists of H.N.C. standard for a variety of interesting investigations in a rapidly expanding private research organization. Good prospects for the right people. Five-day week, pension scheme.—Write for application form to the J. A. Radley Research Institute, 220 Elgar Road, Reading, Berks.

ASSISTANT REQUIRED BY SCIENTIFIC journalist, proprietor of small commercial information service. Chemical training essential but not necessarily of degree standard. Previous experience not required but preference given to intelligent person with interest in literature research and abstracting work in Central London area. Time allowed for approved language study. Salary £540 per annum.—Apply in handwriting to R. H. Chandler, 32 Manaton Road, London, S.E.15.

THE BRITISH DRUG HOUSES LTD. HAVE a vacancy in their Production Department for an Organic Chemist aged 26 to 35 years with B.Sc. degree or equivalent, to supervise some aspects of their Steroid Hormone manufacture. Knowledge of this branch of chemistry is desirable and some managerial experience will be advantageous. Salary according to qualifications. The Company operates a superannuation fund, life assurance and profit sharing schemes.—Applications, with full details, to: Ref. HAC/BS, Personnel Manager, The British Drug Houses Ltd., Graham Street, London, N.1.

NEW ZEALAND
AGRICULTURE DEPARTMENT

Applications are invited for the undermentioned vacancy: No. 1262—Scientific Officer, Levin, Agriculture Department, New Zealand. Duties: Pest control problems of field and horticultural crops and the identification of insect pests. Methods of control of pests, including stored product pest, particularly primary products. An interest in taxonomy would be an advantage. Qualifications desired: A degree in science or agricultural science, with zoology or agricultural zoology as a major subject. Salary up to £1,120 a year dependent upon qualifications and experience. Promotion above £1,120 is on scientific merit. An outstanding officer could rise to £2,025 a year. Passages: Steamer fares of up to £165 each for the appointee and his wife, and pro rata for dependent children will be paid. Incidental expenses: Up to £35 for a single person and £100 for a married man can be claimed to cover the cost of taking personal effects to New Zealand.

Inquiries quoting reference B11/2/41, should be addressed to the High Commissioner for New Zealand, 415 Strand, London, W.C.2, who will furnish further details and application forms. Completed applications to be lodged with his office not later than March 3, 1961.

CITY OF LIVERPOOL
EDUCATION COMMITTEE
COLLEGE OF TECHNOLOGY
BYROM STREET, LIVERPOOL, 3

Principal: S. A. J. Parsons, B.Sc.(Econ.), M.I.Mech.E., M.I.Prod.E., M.B.I.M.

DEPARTMENT OF CHEMISTRY AND BIOLOGY

Applications are invited from suitably qualified men and women for the appointment of Lecturer in Chemistry (full-time). Duties to commence as soon as possible. Salary, £1,370 by £35 to £1,550 per annum (Burnham Technical Report). Commencing salary may be assessed according to previous industrial or professional experience. Applicants should have had experience in one of the following fields; electron microscopy, oils and fats, or theoretical chemistry; they should be prepared to undertake research.

Application form (returnable by February 10, 1961) and further particulars from H. S. Magnay, M.A., Director of Education, 14 Sir Thomas Street, Liverpool, 1.

THOMAS ALKER,
Town Clerk and Clerk to the Local Education Authority. (J.6610.)

UNIVERSITY OF MANCHESTER

Applications are invited for the post of Research Assistant in the Computing Machine Laboratory, tenable in the first instance for a period of approximately one year. Applicants should have a degree in mathematics or equivalent qualifications. The person appointed will be required to assist in research into the use and design of electronic computers. Previous experience of electronic computers is desirable but not essential. The salary will be according to age and qualifications.

Applications should be sent not later than February 11, 1961, to the Registrar, the University, Manchester 13, from whom further particulars and forms of application may be obtained.

UNIVERSITY OF SOUTHAMPTON

Applications are invited for the post of Lecturer or Assistant Lecturer in the Department of Mechanical Engineering. Candidates should have experience in hydraulics, elasticity or materials. Salary scales: Lecturer, £1,050 by £50 to £1,400 by £75 to £1,850 with an efficiency bar at £1,475. Assistant Lecturer, £800 by £50 to £950. The initial salary will depend on qualifications and experience.

Further particulars should be obtained from the Secretary and Registrar, the University, Southampton, to whom applications (seven copies from United Kingdom applicants), should be sent not later than February 18, 1961.

UNIVERSITY OF MANCHESTER

Applications are invited for the post of Research Assistant in the Computing Machine Laboratory, tenable in the first instance for a period of approximately one year. Applicants should have a degree in mathematics or equivalent qualifications. The person appointed will be required to assist in the operation of a Computing Service on the Mercury and Atlas electronic computers. Previous experience of electronic computers is desirable but not essential. The salary will be according to age and qualifications.

Applications should be sent not later than February 4, 1961, to the Registrar, the University, Manchester, 13, from whom further particulars and forms of application may be obtained.

HAREFIELD HOSPITAL
HAREFIELD, MIDDX.

SENIOR LABORATORY TECHNICIAN (Grade I) and SENIOR LABORATORY TECHNICIAN (Grade II) with special experience in haematology and blood transfusion work, required for the above General and Chest Hospital.

London weighting payable.

Applications, with names of two referees, to the Hospital Secretary.

FEDERAL GOVERNMENT OF NIGERIA

RESEARCH OFFICERS

REQUIRED by the Federal Institute of Industrial Research of the Ministry of Commerce and Industry, Oshodi, near Lagos, to carry out one of the following duties under the direction of senior officers:

(a) Laboratory research and development work on the extraction and use of vegetable oils, essential oils.

(b) On fermentation processes in connection with local fruit supplies and farm wastes.

(c) On leather, tanning, wood extracts, gums, resins, drugs, dyes.

(d) On coal products and by-products, tar distillation, etc.

(e) To carry out pilot plant investigations and factory scale development work on food processing, vegetable oil extraction, fibres, wood pulp, and wood extracts and other indigenous raw materials.

(f) To carry out pilot plant investigations and factory scale development work on coal processing and tar distillation.

All the Research Officers will be expected to carry out laboratory research and development work on any Nigerian raw material.

Candidates, men and women acceptable, must possess a first- or second-class honours degree in chemistry, biochemistry or chemical technology or an equivalent qualification. They must have at least two years' postgraduate experience and a flair for research and a capacity for clear imaginative thinking.

Appointment on contract for one tour of 12 to 18 months in the first instance with prospect of extension. Salary according to qualifications and experience in the scale £1,080 to £2,040 per annum (including Inducement Addition), plus gratuity of £150 per annum on satisfactory completion of service. Outfit allowance of £60 on salaries under £1,741. Free passages for officers and wives. Children's allowances while separated. Liberal home leave on full pay. Income tax at low local rate. Quarters at low rent.

Write for application forms and further particulars within ten days of publication, stating briefly age, qualifications and experience, to the Recruitment Attaché, Office of the High Commissioner for Nigeria, Nigeria House, 9 Northumberland Avenue, London, W.C.2, quoting E.14/4.

THE BRITISH CERAMIC RESEARCH Association invites applications for a post in the Liaison Department of its Pottery Division. The work involves the development of new liaison activities between the Association and the industry, and requires a man with scientific or technological qualifications who has had experience in the ceramic industry.—Applications should be addressed to the Director of Research, the British Ceramic Research Association, Queens Road, Penkhull, Stoke-on-Trent.

UNIVERSITY OF SHEFFIELD
IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWSHIPS

Applications are invited for Imperial Chemical Industries Fellowships tenable at the University of Sheffield. Fellowships may be awarded for the purpose of carrying out original research in chemistry, physics, engineering (including chemical engineering), metallurgy, pharmacology, or related subjects, and will be tenable from October 1, 1961. Save in exceptional circumstances Fellows will be required to carry out the whole of their research work in Sheffield. Applicants should preferably hold the degree of Ph.D., or have equivalent research experience. The annual stipend of a Fellow will depend upon age, qualifications and experience, but will be within the range £800 to £1,100, together with F.S.S.U. provision. Fellowships will be tenable for a period to be decided in each case, but not exceeding three years in all.

Applications (eight copies), stating age, details of career and qualifications, publications and an outline of the proposed research, together with the names of two referees, should be sent, not later than February 28, 1961, to the Registrar, the University, Sheffield, 10, from whom further inquiries may be made.

INSTITUTE OF OPHTHALMOLOGY
UNIVERSITY OF LONDON
JUDD STREET, LONDON, W.C.1

Vacancies exist for Laboratory Technicians (A) In Department of Pathology, for work on (1) Histology and (2) Bacteriology and/or Immunology. Grading up to Senior II according to experience and qualifications. And (B) in Research Department for work in Physiological Research of the Eye.

Further particulars from and applications, with names of two referees, to Secretary at above address.

UNIVERSITY OF LONDON
READERSHIP IN APPLIED MATHEMATICS AT QUEEN MARY COLLEGE

The Senate invite applications for the Readership in Applied Mathematics tenable at Queen Mary College (salary £1,675 to £1,975 to £2,425 a year plus £80 London allowance).

Applications (ten copies), must be received not later than February 24, 1961, by the Academic Registrar, University of London, Senate House, W.C.1, from whom further particulars may be obtained.

MIDDLESEX HOSPITAL MEDICAL SCHOOL
DEPARTMENT OF BIOLOGY AS APPLIED TO MEDICINE

Applications are invited for the post of Lecturer in Radiation Biology in the Department, the appointment to begin in October, 1961. The successful candidate will be expected to participate in the teaching of pre-medical, medical, and postgraduate students, but ample opportunities will be offered for research.

Applications, in triplicate, and with the names of two referees, should be made before April 1, 1961, to the Secretary, Department of Biology as Applied to Medicine, Middlesex Hospital Medical School, London, W.1, from whom further particulars can be obtained.

UNIVERSITY OF WESTERN ONTARIO
DEPARTMENT OF BOTANY

Applications are invited for a Postgraduate Research Fellowship for the study of micro-organisms involved in cellulose decomposition. Annual stipend $2,500 for at least three years. Date of appointment to be arranged.

Applications, with curriculum vitae and names of two referees, should be sent, not later than February 28, 1961, to Professor C. J. Hickman, Department of Botany, University of Western Ontario, London, Canada, from whom further information can be obtained.

UNIVERSITY OF LEEDS
ELECTRONIC COMPUTING LABORATORY

Applications are invited for the post of Computing Assistant in Electronic Computing. Salary within the range £600 to £950 a year; tenure three years. Applicants should possess an honours degree in mathematics or in a pure or applied science.

Applications (three copies), stating date of birth, qualifications and experience, together with the names of two referees, should reach the Registrar, the University, Leeds, 2 (from whom further particulars may be obtained), not later than February 17, 1961.

GRADUATE CHEMIST

A vacancy exists at our

NEWCASTLE FACTORY

for a Graduate Chemist to work on PROCESS CONTROL and DEVELOPMENT in the field of DECORATIVE LAMINATES.

Applicants should be University Graduates, and experience in this field would be an advantage, although not essential.

This is an outstanding opportunity for a young man to join a

NEWLY-FORMED DEPARTMENT

and the prospects are excellent.

There is a pension scheme in operation and the salary will be fully commensurate with ability and qualifications.

Applications in writing, giving full details of experience, should be addressed to:

Personnel Manager,
COMMERCIAL PLASTICS LTD.,
75 Grosvenor Street,
London, W.1.

UNIVERSITY OF LONDON

(British Postgraduate Medical Federation)
INSTITUTE OF NEUROLOGY
(QUEEN SQUARE)
KNOOP

Applications for this Fellowship (which may be held for up to seven years) are invited from medical or science graduates. The Fellow will work in the Department of Chemical Pathology and will be engaged in the study of the degenerative neurological disorders of the central nervous system, especially those of an hereditary or familial nature.

Further details of the nature and scope of the research may be obtained from Professor J. N. Cumings at the Institute of Neurology (Queen Square), The National Hospital, Queen Square, London, W.C.1.

UNIVERSITY OF NOTTINGHAM

Two Lecturers in Education (men or women) required with qualifications in any one of the following: (a) Classics; (b) Arts degree, with Secondary Modern School experience; (c) Science degree (pure or applied) with experience in Secondary Technical Schools and/or further education. Salary scale £1,050 to £1,850 per annum, initial salary according to qualifications and experience, with F.S.S.U. benefits and children's allowance.

Conditions of appointment and form of application, to be returned by February 11, 1961, from the Registrar.

EAST MALLING RESEARCH STATION. Vacancy for Botanist, who is keen to apply a variety of approaches, including a study of development anatomy, to the problem of how growing conditions affect the storage behaviour of apples. Appointment in Scientific Officer grade. Good honours degree essential; postgraduate training or research experience desirable. Details and application forms from Secretary, East Malling Research Station, Maidstone, Kent. Closing date February 20.

PATENT EXAMINERS AND PATENT Officers. Pensionable posts for men and women for work on the examination of Patent applications. Age at least 21 and under 29 on December 31, 1961, with extension for regular forces service and Overseas Civil Service. Qualifications: Normally a degree, or a Diploma in Technology, with first- or second-class honours in physics, chemistry, engineering or mathematics, or equivalent attainment, or professional qualification, e.g., A.M.I.C.E., A.M.I.Mech.E., A.M.I.E.E., A.R.I.C., A.Inst.P. London salary £759 to £1,704, provision for starting pay above minimum. Promotion prospects.—Write Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting **S/128/61.**

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE

DEPARTMENT OF CHEMISTRY

Applications are invited for the post of Assistant Lecturer at a salary on the scale £850 by £50 to £950. The applicant should have special qualifications in inorganic chemistry or in physical chemistry.

Applications (six copies), giving the names of three referees, should be sent to the Registrar, University College, Cathays Park, Cardiff, from whom further particulars may be obtained. Closing date for applications, February 28, 1961.

CHEMICAL ENGINEERS

A large and progressive chemical company engaged in the manufacture of organic and inorganic chemicals, requires engineers who possess an honours degree in chemical engineering or associate membership of the Institute of Chemical Engineers.

Applicants should preferably be 25/30, and should have had at least three years' experience in either production research or factory development department. Experience in estimation and process design is desirable but not essential.

The positions are progressive and there is a contributory pension scheme.

Apply to Box No. 944, T. G. Scott and Son, Ltd., 1 Clement's Inn, London, W.C.2.

RESEARCH INTO AVIAN DISEASES

A SCIENTIST experienced in the field of avian pathology is sought by a Company wishing to sponsor research in this speciality. Poultry will not be a study. Candidates may have a Veterinary or Zoological or other appropriate qualification and will have had several years of practical experience of both infective and nutritional disease in birds. He or she will be required to establish and control an aviary and associated laboratory.

The salary will not be less than £2,000 per annum.

Box No. G1876, c/o Whites, 72 Fleet Street, London, E.C.4.

QUEEN MARY COLLEGE

(UNIVERSITY OF LONDON)

Applications are invited for a new post of Assistant Lecturer in Botany tenable from October 1, 1961. Preference will be given to applicants with a research interest in some aspect of experimental botany. Salary scale £800 by £50 to £950 plus a London allowance of £60, F.S.S.U. participation and Family allowance of £50 for each child.

Application forms, obtainable from the Registrar, Queen Mary College, Mile End Road, E.1, to be returned by February 20, 1961.

QUEEN MARY COLLEGE

(UNIVERSITY OF LONDON)

Applications are invited for the post of Assistant Lecturer in Geology with special interest in Hard Rock Petrology and Mineralogy. Tenable from October 1, 1961. Salary scale £800 by £50 to £950 plus a London allowance of £60, F.S.S.U. participation and family allowance of £50 for each child.

Application forms, obtainable from the Registrar, Queen Mary College, Mile End Road, E.1, to be returned by February 20.

UNIVERSITY OF WESTERN ONTARIO, London, Canada: N.R.C. postdoctoral Research Fellowship with preference for structural geology but other fields considered if candidate has satisfactory qualifications. Stipend is $4,000 single, $5,000 married, tax free, plus travel and generous equipment allowance. Application blanks, and information from Chairman, Geology Department. Closing date May 1, 1961.—Applications from candidates for graduate degrees also received until April 1.

A SENIOR MICROBIOLOGIST

is required at Worthing to take charge of the Microbiological Laboratory associated with Antibiotic Production.

Applicants should be qualified and preferably have had previous experience of Microbiological Assay methods, sterility testing and culture maintenance techniques.

Good salary, non-contributory pensions and staff profit sharing schemes in operation.

Apply in writing, giving details of age, qualifications and experience to: Personnel Officer, Beecham Research Laboratories Ltd., Clarendon Road, Worthing, Sussex.

UNIVERSITY OF NEW ENGLAND

ARMIDALE, NEW SOUTH WALES
LABORATORY ASSISTANTS AND TECHNICIANS

Applications are invited for appointment to positions of Laboratory Assistant and Technician in the Faculty of Rural Science. Applications will be received from people who are qualified to assist with teaching and research in chemistry, including biochemistry and plant and soil chemistry, physiology, microbiology and pathology. In-service training may be undertaken towards a Diploma in Science Technology. Commencing wages will be fixed according to qualifications and experience up to £A.26 5s. 9d. per week (males) and £A.22 8s. 10d. per week (females) subject to future variations in the basic wage. Four weeks annual leave; liberal sick leave and long service leave. Fares will be paid and removal expenses of up to £A.200.

Applications from within Australia and New Zealand should be forwarded to reach the undersigned not later than February 24, 1961. Applicants outside Australia and New Zealand should forward their applications to the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1, by the same date. They should also forward an additional copy of their application by air mail to the undersigned. Applications should give full particulars of qualifications and experience, together with the names of two referees.

T. C. LAMBLE,
Registrar.

University of New England,
Armidale, N.S.W., Australia.

POSTDOCTORATE FELLOWSHIP IN NUCLEAR PHYSICS

A National Research Council of Canada Postdoctorate Fellowship will be available in 1961-62 for experimental work in nuclear spectroscopy or related topics in the Physics Department of Queen's University. The stipend, which is tax-free, is $4,000 for a single person and $5,000 for a married male.

Inquiries should be addressed to Dr. H. W. Taylor, Department of Physics, Queen's University, Kingston, Ontario, Canada.

UNIVERSITY OF LIVERPOOL

Applications are invited for the post of Assistant Lecturer or Lecturer in the Department of Pure Mathematics. The initial salary will be within the range £800 to £1,250 per annum, according to age, qualifications and experience.

Applications, stating age, academic qualifications and experience, together with the names of three referees, should be received not later than February 3, 1961, by the Registrar, from whom further particulars of the conditions of appointment may be obtained. Ref. CV/N.

ESSEX COLLEGE

ASSUMPTION UNIVERSITY OF WINDSOR
WINDSOR, ONTARIO, CANADA

The Department of Mathematics offers Graduate Assistantships to candidates wishing to proceed to the M.Sc. in Mathematics. Stipend up to $2,000 for eight months depending on qualifications and duties in that Department. Assistants may pursue courses in pure or applied mathematics.

Inquiries should be addressed to the Head of the Department of Mathematics.

FIELDSMAN. EXPERIENCED PERSON required before April 1 who will be responsible for the placing and supervision of the growing and harvesting of all our crops of Aberystwyth seeds, and advice to Representatives on leys, etc. A house is available. Pension Fund.—Please write in confidence to Managing Director, stating age, experience and salary required to: W. Sinclair and Son Limited, 35 Market Place, Boston, Lincolnshire.

UNIVERSITY OF MANCHESTER
IMPERIAL CHEMICAL INDUSTRIES FELLOWSHIPS

Applications are invited for the above Research Fellowships, founded by Imperial Chemical Industries Ltd., tenable in the University and available for research in various branches of Chemistry, Chemical Engineering, Engineering, Technology, Physics and allied subjects. The value of the Fellowships will be within the range of £800 to £1,100 per annum according to qualifications and experience.

Regulations governing the award of the Fellowships may be obtained from the Registrar, the University, Manchester 13, to whom applications should be sent not later than February 14, 1961.

UNIVERSITY OF MANCHESTER
TURNER AND NEWALL RESEARCH FELLOWSHIPS

Applications are invited for the above Research Fellowships, founded by Messrs. Turner and Newall Ltd., tenable in the University and available for research in engineering, inorganic chemistry, physics and allied subjects. The value of the Fellowships will be within the range of £800 to £1,100 per annum according to qualifications and experience.

Regulations governing the award of the Fellowships may be obtained from the Registrar, the University, Manchester 13, to whom applications should be sent not later than February 14, 1961.

PEA GROWING RESEARCH ORGANIZATION LTD.

Applications are invited, not later than February 3, from male graduates in agriculture, or related subject, for the following posts: (1) Senior Technical Officer. Commencing salary up to £1,000 per annum. (2) Technical Officer. Commencing salary up to £700 per annum.

Further particulars and application forms may be obtained from the Secretary, Pea Research Station, Yaxley, Peterborough.

STOKE MANDEVILLE HOSPITAL
AYLESBURY

Assistant Biochemist required in the Area Pathology Laboratory based at the above Hospital. Applicants should possess first- or second-class honours degree in chemistry or biochemistry, or A.R.I.C. Whitley Council conditions of service. Salary £925 to £1,150 per annum after (for new entrants only) a probationary period. The post offers a wide variety of experience in a well-equipped and pleasant laboratory.

Applications, giving full details of qualifications etc., together with names of two referees, to be forwarded to the Administrative Officer as soon as possible.

UNIVERSITY OF LEICESTER

Applications are invited for I.C.I. Research Fellowships in Chemistry, Physics, Biochemistry or Geology. Salary within the range £700 to £1,000 a year, according to qualifications and experience, with F.S.S.U. and family allowances.

Applications, giving age, full particulars of qualifications, training and experience, list of publications, and the names of two referees, should be sent not later than March 4, to the Registrar, from whom further particulars may be obtained.

RESEARCH ASSISTANT WANTED AT Stoke Mandeville Hospital for immunological work. The person appointed would work directly with the pathologist undertaking the research. Immunological background and a knowledge of serological techniques desirable. Salary £750 to £1,000 per annum according to qualifications.—Inquiries and applications, giving details of experience and the names of two referees, to the Pathologist, Stoke Mandeville Hospital, Aylesbury, Bucks.

THE SCIENTIFIC CIVIL SERVICE NEEDS men and women for pensionable posts as: (a) Experimental Officers and (b) Assistant Experimental Officers in Mathematics, Physics, Meteorology, Chemistry, Metallurgy, Biological Sciences, Engineering, Miscellaneous (Geology, Library and Technical Information Services). Candidates must, on December 31, 1961, be at least 26 and normally under 31 for (a), and at least 18 and normally under 28 for (b). Qualifications should normally include H.S.C., or G.C.E., or equivalent, or H.N.C., a University degree, or a Diploma in Technology. Provisional admission if taking examinations in 1961. London salary scale (a) £1,117 to £1,376; (b) £465 10s. (at 18) to £826 (26 or over) rising to £1,009. Promotion prospects. Further education facilities. —Write Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting **S/94-95/61.**

CHELSEA COLLEGE OF SCIENCE AND TECHNOLOGY
MANRESA ROAD, LONDON, S.W.3
DEPARTMENT OF MATHEMATICS

Applications are invited for the post of Reader in Applied Mathematics. Salary scale: £1,800 by £50 to £2,100 per annum, plus London allowance of £38 or £51 according to age.

Information about the Department, together with further particulars of the post, may be obtained from the Clerk to the Governors. Applications by February 15, 1961.

SOUTH WARWICKSHIRE HOSPITAL GROUP

Biochemist (Principal Grade) required to take charge of the Biochemical Department of the Group Laboratory, Lakin Road, Warwick. The appointment, which is under Whitley Council scales and conditions, will be vacant in April. Hospitals may be visited by candidates.

Applications, giving age, details of experience and qualifications and the names of three referees, to Group Secretary, 50 Holly Walk, Leamington Spa, by February 18, 1961.

FELLOWSHIPS AND ASSISTANTSHIPS for advanced degree students in the fields of metallurgy, ceramics and semiconductors. A new Materials Research Centre provides exceptional facilities for basic research and graduate studies in kinetics physical ceramics and metallurgy, imperfection studies in solids, physics of solids, thermodynamics and X-ray diffraction.—Applicants with degrees in mathematics, the physical sciences or engineering will be considered. Department of Materials Science, the Technological Institute, Evanston, Illinois.

THE LABORATORY OF BACTERIOLOGY of Cornell University invites applications for Teaching and Research Assistantships. Applicants must be qualified to work for an advanced degree (M.S. or Ph.D.) in Bacteriology, although prior bacteriology training is not required. Stipends are usually in the range of $2,200 to $3,200 per annum. Applications for the academic year 1961-62 should be completed by April.—Further details and information may be obtained from Professor E. A. Delwiche, Laboratory of Bacteriology, Cornell University, Ithaca, New York, U.S.A.

TECALEMIT LIMITED, PLYMOUTH, Devon, have a vacancy for the post of Physicist or Technologist in their Laboratory for testing non-metallic materials. Applications are invited from men under 30 years of age with a University degree who have not less than three years industrial or research experience, preferably connected with one of the following materials: plastics, filter media, rubber and adhesives. The selected candidate will find interesting and varied work in the congenial atmosphere of a modern and expanding factory. The Company offers a contributory Pension-Life insurance scheme, together with a comprehensive range of welfare and recreational activities.—Please apply, in strictest confidence, to the Personnel Manager, giving age, together with qualifications, experience and present salary.

VETERINARY OFFICERS, RESEARCH Officers, Assistant Veterinary Investigation Officers: Ministry of Agriculture, Fisheries and Food. Pensionable posts for men and women aged at least 23. M.R.C.V.S. normally required, and postgraduate experience desirable. Present vacancies for Research Officers in virology, bacteriology and biochemistry. National salary scales £926 (at 23) to £1,269 (at 32 or over) rising to £1,420, then to £1,778. Promotion prospects. —Write Civil Service Commission, Burlington Gardens, London, W.1, for application form, quoting 130-173-265/61. Early application advised.

PLANT PHYSIOLOGIST/BIOCHEMIST TO take an active part with a team of plant physiologists in work on the physiology of host-resistance to the diseases of fruit plants. Adequate knowledge of the fundamentals of biological chemistry and postgraduate experience essential; under 35. Salary according to age and experience, F.S.S.U.; appointment at once or in late summer.—Full details and forms of application may be obtained from the Secretary, East Malling Research Station, East Malling, Maidstone, Kent, to whom they should be returned not later than March 20.

SENIOR ANALYST REQUIRED (MALE OR female) for Research Establishment situated at Walton Oaks, near Tadworth, Surrey. Experienced in general analytical duties, etc., or would consider young graduate desiring to make a career in analytical chemistry.—Apply to Personnel Manager, Vitamins Ltd., Upper Mall, London, W.6.

UNIVERSITY OF BELFAST

The Senate of the Queen's University of Belfast invites applications for a Lectureship in Applied Mathematics from October 1, 1961. Salary range £1,050 to £1,850 plus contributory pension rights under the F.S.S.U. Initial placing on the salary scale will depend on qualifications and experience. Applications should be received by February 28, 1961.

Further particulars may be obtained from G. R. Cowie, M.A., LL.B., J.P., Secretary.

UNIVERSITY OF NOTTINGHAM
DEPARTMENT OF AGRICULTURE

Applications are invited for the following posts at the School of Agriculture, Sutton Bonington: Lecturer in Agriculture (Animal Production). Salary scale £1,050 to £1,850 per annum, with F.S.S.U. benefits and children's allowance. Departmental Assistant in Animal Physiology. Initial salary £750 per annum rising to £850 at end of first year.

Forms of application and conditions of appointment, to be returned by February 4, from the Registrar, Nottingham University.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY
RESEARCH STUDENTSHIPS IN GEOCHEMICAL PROSPECTING

Applications are invited from Geology Graduates for Research Studentships in applied Geochemistry (£600 to £800 per annum for two years) starting October 1, 1961. Successful applicants will carry out field work overseas during not more than two terms.

Apply Dr. Webb, Geology Department, Imperial College, London, S.W.7, before June 1.

UNIVERSITY OF LONDON
READERSHIP IN VETERINARY MEDICINE AT ROYAL VETERINARY COLLEGE

The Senate invite applications for the Readership in Veterinary Medicine, tenable at the Royal Veterinary College (salary scale £1,675 to £1,975 to £2,425 a year plus £80 London allowance).

Applications (ten copies), must be received not later than February 28, 1961, by the Academic Registrar, University of London, Senate House, W.C.1, from whom further particulars may be obtained.

UNIVERSITY OF GLASGOW
MECHAN CHAIR OF AERONAUTICS AND FLUID MECHANICS

The University Court will shortly consider an appointment to the Mechan Chair of Aeronautics and Fluid Mechanics. The Chair is a full-time appointment.

Particulars as to duties, salary and conditions of appointment may be obtained from the undersigned, with whom applications (20 copies) should be lodged, not later than March 10, 1961.

ROBT. T. HUTCHESON,
Secretary of University Court.

TECHNICIAN OR JUNIOR TECHNICIAN required for the Human Cytogenetics Group of the Paediatric Research Unit, Guy's Hospital Medical School, to assist with studies of human chromosomes. Previous experience in cytology or cytogenetics not essential, but some experience in either bacteriology, virology or microphotography would be an advantage. Salary on scale according to age, qualifications and experience.—Applications (two copies) should be sent to the Secretary, Paediatric Research Unit, Guy's Hospital Medical School, London Bridge, S.E.1.

THE BRITISH NON-FERROUS METALS Research Association, a leader in the field of specialized information services, is strengthening its Information Department and is about to make a senior and a junior appointment both of which will offer scope for advancement and carry salaries commensurate with responsibility and experience. Applications are accordingly invited from graduates in metallurgy, physics or chemistry. For the senior post, experience of either specialized information services or in the preparation and presentation of technical information is required. The junior post provides experience in methods of gathering and distributing information from world sources as well as training in editorial work.—Write Secretary, B.N.F.M.R.A., Euston Street, London, N.W.1.

TECHNICAL INFORMATION OFFICER REquired to head staff of 12 dealing with inquiries on wide range of industrial and allied subjects. Central London. Salary up to £1,750.—Box 946, T. G. Scott and Son, Ltd., 1 Clement's Inn, London, W.C.2.

SALTERS' INSTITUTE OF INDUSTRIAL CHEMISTRY

FELLOWSHIPS

Applications are invited for Salters' Fellowships, of value in the range of £800 to £1,000 per annum (plus University fees and 10 per cent contribution to F.S.S.U.). These Fellowships may be held by honours graduates in chemistry, biochemistry, physics or engineering who desire to obtain further training in research in Chemistry, Biochemistry or Chemical Engineering. Candidates should have obtained a doctor's degree or have had not less than three years' postgraduate experience by the time of taking up the Fellowships. Fellowships will be tenable, in the United Kingdom or abroad, for one year from September 1, 1961, and may be renewed for one further year.

Applications should be received by the Clerk of the Salters' Company, 36 Portland Place, London, W.1, by March 28, 1961. Applications may also be made at any time during the year but such late applications will only receive consideration if there are vacancies. Forms of application may be had on request.

BOURNEMOUTH EDUCATION COMMITTEE

BOURNEMOUTH MUNICIPAL COLLEGE OF TECHNOLOGY AND COMMERCE
DEPARTMENT OF SCIENCE

Lecturer in Mathematics required for May 1, 1961, to teach mathematics up to B.Sc. General degree level and also certain aspects of computing. Applicants should possess good academic qualifications in mathematics and either experience of or an interest in numerical analysis. Salary in accordance with the Burnham Technical Scale, viz.: Lecturer, £1,370 to £1,550.

Further particulars and form of application may be obtained from the Chief Education Officer, Town Hall, Bournemouth.

TIN RESEARCH INSTITUTE

Graduate required to undertake research on the chemistry of metal surfaces. Minimum starting salary £800 per annum. Publication of research is encouraged and opportunity exists for the submission of work for higher degrees. F.S.S.U. benefits.

Applications to the Director, Tin Research Institute, Fraser Road, Greenford, Middlesex.

UNIVERSITY OF ABERDEEN

Applications are invited for an Assistant in Zoology in the Department of Natural History. Preference may be given to candidates interested in vertebrate zoology. Salary £800 to £950, F.S.S.U. and children's allowance.

Particulars from the Secretary, the University, Aberdeen, with whom applications (two copies) should be lodged not later than February 28, 1961.

UNIVERSITY OF NOTTINGHAM

Applications are invited for an Assistant Lectureship in Botany. Special qualifications in algology are essential. Salary within the scale £800 by £50 to £950 per annum.

Conditions of appointment and form of application, to be returned by February 18, from the Registrar.

UNIVERSITY OF CAMBRIDGE

Applications are invited for a University Demonstratorship in Metallurgy: appointment will be from October 1, 1961. Applications close on March 31, 1961.

Details of duties, salary, etc., may be obtained from Dr. F. B. Kipping, University Chemical Laboratory, Lensfield Road, Cambridge.

UNIVERSITY OF CAMBRIDGE

I.C.I. FELLOWSHIPS

Applications are invited for Imperial Chemical Industries Fellowships, value within the range £800 to £1,100 a year, tenable in the University and available for research in physics, chemistry, colloid science, biochemistry, engineering, metallurgy, pharmacology, chemotherapy, or related subjects.

Applications must be received not later than April 29, 1961. Regulations governing the award of the Fellowships may be obtained from the Secretary General of the Faculties, the Old Schools, Cambridge, to whom all applications should be addressed.

FACULTY POSITION IN ORGANIC CHEMistry or plant biochemistry. Duties include graduate and undergraduate instruction and direction of graduate research. Rank and salary dependent upon qualifications.—Inquiries should be addressed to Head, Department of Chemistry, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

NATIONAL INSTITUTE OF AGRICULTURAL ENGINEERING

WREST PARK, SILSOE, BEDFORDSHIRE

Physicist or Soil Physicist (Ref. SD.1) for research on the mechanical and physical properties of agricultural soils and their relationship to the performance of tillage implements. Qualifications: First- or second-class honours degree in physics with at least two years' postgraduate experience in research or in natural science with at least two years' experience or training in soil science.

Engineer (Ref. SD.2) for research on the design and performance of plourhs and cultivation machinery and on improved methods of cultivation. Qualifications: First- or second-class honours degree in mechanical or agricultural engineering or equivalent and with postgraduate experience in agriculture.

Appointments in Scientific Officer or Senior Scientific Officer grades at starting salaries, according to experience, on the scales £717 to £1,186 and £1,302 to £1,604 respectively, with superannuation under F.S.S.U.

Application forms from Secretary to be returned by February 20, 1961, quoting appropriate reference number.

NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING

ENGINEERING DEPARTMENT

A TESTING OFFICER is required for performance testing of dairy machinery. Applicants should preferably have experience of engineering testing work and an educational qualification to H.N.C. standard.

The appointment will be made in the Experimental Officer grade, the salary scale for which is £1,057 to £1,296 per annum, with superannuation.

Applications, stating qualifications and experience, age and present appointment, to the Secretary, N.I.R.D., Shinfield, Reading, quoting Ref. 61/3.

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE

Applications are invited for two posts of Assistant Lecturer or Lecturer in the Department of Mathematics: 1, With qualifications in any branch of pure mathematics, and 2, with special interests in numerical analysis or mathematical statistics.

Further particulars may be obtained from the Registrar, University College, Cathay's Park, Cardiff, to whom applications (six copies), should be sent not later than February 28, 1961.

BEDFORD COLLEGE (UNIVERSITY OF London), Regent's Park, N.W.1. Technician required with some knowledge and experience of maintaining instruments and electronics apparatus. Salary range £490 to £815 per annum, according to qualifications and experience, plus London Weighting. Good prospects of promotion.—Applications to the Secretary.

OXFORD UNIVERSITY COMPUTING Laboratory invite applications for the Ferranti Fellowship in Computing, for one or two years from October 1, 1961. The successful candidate, who should have at least two years' research experience, will be expected to do original work in any field connected with computation or other application of digital computers, and will have access to a Ferranti Mercury. The Fellowship is open to candidates of any nationality, has a stipend of £900 per annum, and is subject to the provision of F.S.S.U., where applicable.—Applications, with details of academic and research experience, and the names of two referees, should be sent before July 31, 1961, to the Director, University Computing Laboratory, 9 South Parks Road, Oxford.

MISCELLANEOUS

MURDOCH TRUST

For the BENEFIT of INDIGENT BACHELORS and WIDOWERS of good character, over 55 years of age, who have done "something" in the way of promoting or helping some branch of Science. Donations or pensions may be granted to persons who comply with these conditions.

For particulars, apply to MESSRS SHEPHERD & WEDDERBURN, W.S., 16 Charlotte Square, Edinburgh, 2.

TRADE ANNOUNCEMENTS

SILICA CONES AND SOCKETS, VITREOus silica tubing, polished silica discs and glazed sheet always in stock.—Custom built silica/quartz apparatus from Jencons, The Silica Centre, Mark Road, Hemel Hempstead, Hertfordshire. Boxmoor 4641.

GRANTS & SCHOLARSHIPS

EAST MALLING RESEARCH STATION

V. H. BLACKMAN RESEARCH STUDENTSHIP, 1961

The East Malling Research Station Association offers one postgraduate Studentship of £500 per annum (tax free), for training in research upon some fundamental problem arising out of the orchard culture of fruit trees, or their growth, flowering, or fruiting.

The object of the Studentship is to provide an opportunity for training at a centre where excellent facilities exist for the study of perennial plants and of the experimental procedures appropriate to research on them; it is hoped that first-class men will be attracted.

Candidates (men) must be of British nationality and hold a good degree of a university of the United Kingdom in an appropriate subject; their nominators must provide specific recommendations as to their suitability for training for a research career.

Studentships for training in research in the fields of entomology, plant pathology, and pomology already have been awarded, preference will be given to candidates in other fields; it is hoped that it will be possible to make the award for 1961 in plant physiology (studies of growth and form), or in tree nutrition, or in pomology. Candidates in other disciplines will, however, receive consideration.

No undertaking concerning the candidate's subsequent career is either given or required. The Studentship will normally be tenable for three years and it is hoped that full advantage will be taken of the available opportunities for proceeding to a higher degree. In suitable cases the Studentship will be for four years, to enable the selected student to undertake a postgraduate year at a university, prior to commencing his three-year period of research at East Malling.

It is intended that the supervision of the student by a senior member of the Station's staff (a Recognized Teacher in the case of students registered for postgraduate degree of the University of London) shall, wherever possible, be carried out in full collaboration with a senior member of the academic staff of his university. Prior to the termination of the Studentship, the postgraduate will be required to provide a full and satisfactory account of his research in the form of a thesis.

At East Malling the numerous long-term experiments upon the growth and cropping of mature fruit trees are accompanied by numerous small-scale and short-term experiments on younger trees. There are eight research sections (Pomology, Statistics, Plant Physiology, Biochemistry, Fruit Nutrition, Plant Pathology, Entomology, and Plant Protective Chemistry), each well equipped to provide training in appropriate techniques. It is intended that the successful applicant shall not only be enabled to obtain a thorough working knowledge of field experimentation and of the relevant statistical procedures during his tenure, but shall also have the opportunity of developing his scientific experience on as wide a basis as is feasible.

Application forms are obtainable from the Secretary, East Malling Research Station, East Malling, Maidstone, Kent, to whom they should be returned not later than April 15, 1961.

UNIVERSITY OF OXFORD

METALLURGICAL RESEARCH

Several Research Bursaries are offered for work in the Department of Metallurgy on various problems in Physical Metallurgy. The Bursars are expected to read for the Oxford D.Phil. degree, and the work provides valuable training and experience. The Bursaries are of the value equivalent to those of D.S.I.R. Research Studentships (at present £420 per annum tax free, plus approved fees).

Candidates should have a first- or good second-class honours degree in metallurgy, physics or chemistry and should apply as soon as possible to Professor W. Hume-Rothery, Department of Metallurgy, Parks Road, Oxford, from whom full details can be obtained. Applications can be received from those graduating in the Summer of 1961, and those appointed will be expected to begin work on October 1.

SALTERS' INSTITUTE OF INDUSTRIAL CHEMISTRY

SCHOLARSHIPS

Applications are invited for Salters' Scholarships, value £450 to £550 per annum according to circumstances (plus University fees), for a graduate resident in the United Kingdom with an honours degree in chemistry, biochemistry, physics or engineering, for the purpose of receiving either full-time instruction in the principles of Chemical Engineering or further experience by research in Chemistry or Chemical Engineering. Applications may be made before graduation. The Scholarships will be tenable for one year and may be renewed year by year for two further years. Tenure abroad may be permitted in the third year.

Applications should be received by the Clerk of the Salters' Company, 36 Portland Place, London, W.1, by March 28, 1961. Forms of application may be had on request.

NATO GRANTS

for participation in the
CANADIAN THEORETICAL PHYSICS SEMINAR

Two grants of value $750 (£268) each are being offered by the North Atlantic Treaty Organization on a competitive basis to students of theoretical physics from NATO countries to attend the Second Quadriennial Theoretical Physics Seminar of the Canadian Association of Physicists to be held August 13 to September 9 at the University of Montreal. The seminar features lecture series by outstanding theoretical physicists as well as informal discussion on physics.

For further information and application forms write Dr. D. D. Betts, Department of Physics, University of Alberta, Edmonton, Canada. Deadline for applications is April 15.

LECTURES AND COURSES

LANCHESTER COLLEGE OF TECHNOLOGY

COVENTRY
DEPARTMENT OF APPLIED PHYSICS
Short Course on
"RECENT ADVANCES IN NON-DESTRUCTIVE TESTING"
February 23-24, 1961

A short course for physicists and engineers will be held on Thursday and Friday, February 23 and 24, 1961, and will include the following topics: Radiography, Internal Friction, Ultrasonics, Eddy Currents, Surface Crack Detectors, Electromagnetic Methods of Quality Control, Fluoroscopy and Economics.

Fee: £1 2s.

Full particulars and forms of application from the Head of the Department of Applied Physics, Lanchester College of Technology, Priory Street, Coventry.

BATTERSEA COLLEGE OF

LONDON, S.W.11

Postgraduate courses in Crystallography, consisting of one year full-time or two years part-time, will begin on October 2, 1961. These courses prepare for either the Internal degree of M.Sc. (Crystallography) of the University of London, or the College Postgraduate Diploma (D.C.T. (Batt.)). Scholarships are available in certain circumstances.

For further details apply to Dr. D. Lewis, Crystallography Section.

COLLEGE OF AERONAUTICS

TWO-YEAR DIPLOMA COURSE 1961-1963

Applications are invited from suitably qualified men and women who wish to enrol for the Two-Year Diploma Course which begins in October, 1961. This postgraduate course in Aeronautical Science and Engineering is intended primarily for university graduates in engineering science or mathematics. Technical College students and others who possess a higher national certificate, diploma or equivalent qualification and attain the required entrance examination standard may also be accepted. The curriculum includes the subjects of aerodynamics, aircraft design, electrical and control engineering, materials, production and industrial administration and aircraft propulsion in all of which subjects a major specialization may be taken. Lectures and laboratories in mathematics and flight are obligatory for all students. All applications will be considered by the Board of Entry which may call candidates to attend at the College for written Entrance Examination in Engineering, Physics, Mechanics, and Mathematics, to be held on Monday, March 27, 1961. Exemption from this examination will normally only be given to candidates possessing first- or second-class honours degrees in science or engineering, or reading for honours degrees. The Board may also require attendance for personal interview at a later date. Candidates who possess Bachelor's Degrees with first- or second-class honours in aeronautics, and also in science or engineering if they have adequate postgraduate experience, may at the discretion of the Board of Entry be accepted for entry to the second year of the course and qualify for the Diploma (D.C.Ae.).

Further information about the course and forms of application, which must be completed and returned not later than Saturday, March 4, 1961, may be obtained from the Warden, The College of Aeronautics, Cranfield, Bletchley, Bucks.

MIDDLESEX HOSPITAL MEDICAL SCHOOL

LONDON, W.1
DEPARTMENTS OF PHYSICS AND OF BIOLOGY AS APPLIED TO MEDICINE
M.Sc. in Radiation Biology and Radiation Physics

A two-year course leading to an M.Sc. by examination will be offered from October, 1961. The course is open to selected graduates in the physical or biological sciences or in medicine.

In their first year students will take a course *either* in the fundamentals of modern biology (those with little or no previous biological training) *or* in physics (those with little background in physics). After a qualifying examination at the end of their first year, students will proceed to a common course in advanced radiation biology and physics. The course will be designed to qualify those taking it for later independent research in the field, or for exercising responsibility for radiological protection in the nuclear energy industry. A limited number of Studentships may be available.

Further details of the course and application forms may be obtained from the Secretary, Department of Biology as Applied to Medicine, Middlesex Hospital Medical School, London, W.1. Applications must be received before May 1, 1961.

UNIVERSITY OF LONDON: A LECTURE entitled "Geology of the Polish Carpathian Mountains" will be delivered by Professor M. Ksiazkiewicz (Cracow) at 5.30 p.m. on February 7 at Queen Mary College, Mile End Road, E.1. Admission free, without ticket.—James Henderson, Academic Registrar.

UNIVERSITY OF BIRMINGHAM

GRADUATE TRAINING IN RADIOBIOLOGY

Research (and graduate) training in Radiobiology is provided jointly by the Faculties of Science and Medicine. It is intended for candidates for Ph.D. by research but a few M.Sc. registrations may be accepted. A twelve months introductory course of lectures and practical work is followed by normally two years individual research. M.Sc. candidates take the introductory course only. Research Studentships of the D.S.I.R. may be awarded to suitable applicants and the introductory course has been accepted by the D.S.I.R. as suitable for the tenure of its Advanced Course Studentships.

Applicants holding or expecting to obtain a good honours degree in an appropriate Physical, Biological, or Medical Science should write for further details and forms of application to the Assistant Registrar (Science), the University, Edgbaston, Birmingham, 15.

UNIVERSITY OF NOTTINGHAM

M.SC. DEGREE IN MYCOLOGY

The University offers a one year postgraduate course leading to an M.Sc. degree in mycology by examination for students holding a good honours degree in botany. D.S.I.R. has accepted this course as suitable for the tenure of its Advanced Course Studentships.

Further particulars and application forms are available from the Registrar.

GRESHAM LECTURES. DR. W. H. Steavenson, F.R.A.S., Gresham Professor in Astronomy, will deliver a course of four Lectures entitled "The Sky by Day and Night," on Monday to Thursday, January 30 to February 2 at Gresham College, Basinghall Street, E.C.2. Tel. MONarch 2433.—The Lectures are free and begin at 5.30 p.m.

UNIVERSITY OF LONDON: A COURSE OF three lectures entitled "The Electronic Structure of Metals" will be delivered by Professor A. B. Pippard (Cambridge) at 5.30 p.m. on February 2, 9 and 16, at Imperial College (New Physics Building), Prince Consort Road, South Kensington, S.W.7. Admission free, without ticket.—James Henderson, Academic Registrar.

FOR SALE AND WANTED

ALMOST ANY BACKNUMBERS AND volumes of *Nature* wanted. Also learned and scientific journals, transactions of most kinds. Further: *Notes and Queries*, the *Annual Register*, *Quarterly Review*, *Palmer's* and/or the *Official Index* to the *Times*, *British National Bibliography*, *English Catalogue of Books*, *Journal Royal Philosophical Society*, *Royal Statistical Society*, etc.—H. Pordes, 138 New Cavendish Street, London, W.1. MUSeum 5250.

WANTED, USED UNICAM S.P.500 SPECtrophotometer.—Offers to Box No. 942, T. G. Scott and Son, Ltd., 1 Clement's Inn, London, W.C.2.

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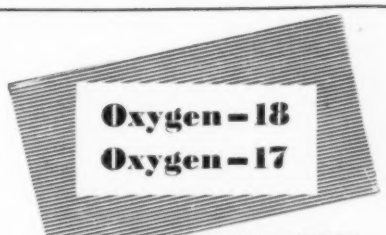

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dehydrated foods

Drying food to preserve it is a technique of considerable antiquity, inevitably so in a world of seasonal food supply. Not that early examples of preserved food were to everyone's taste. There are still some primitive people who prefer a dish of well-rotted fish when there is no fresh food to be had; but they are a minority.

The earliest records of food drying go back to the Sumerians in 3300 B.C. Sun drying was used then, and continued to be used solely, until towards the end of the 18th century when stove and tunnel drying were introduced. But survival was always the prime motive, and while the quality of the dried foods was distinctive—and sometimes interesting—it did not always approximate to that of the fresh food from which it was prepared.

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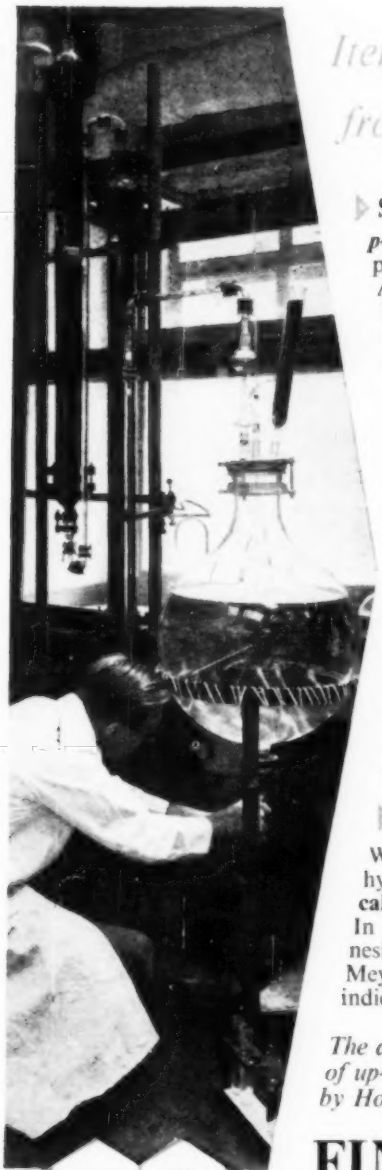

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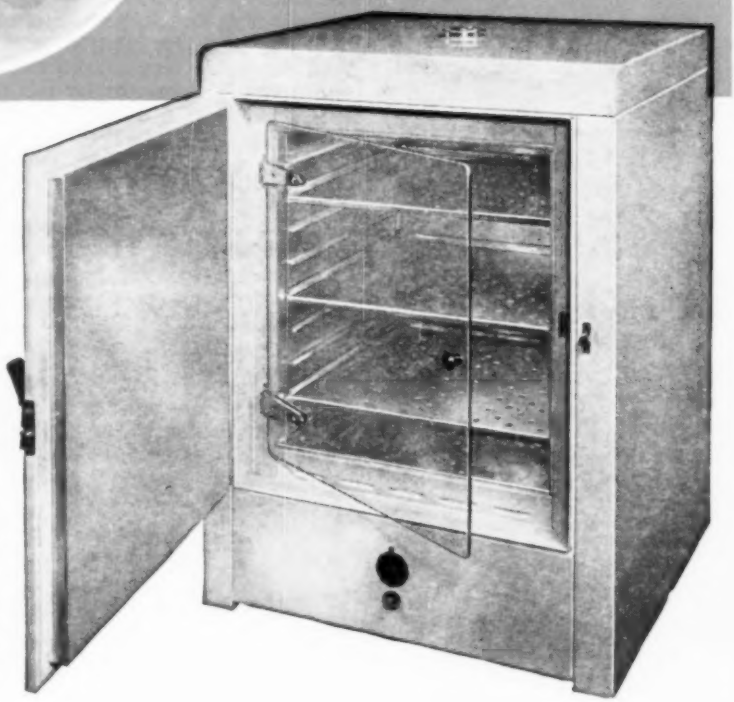

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